ENGINEERING

An Illustrated Weekly Journal

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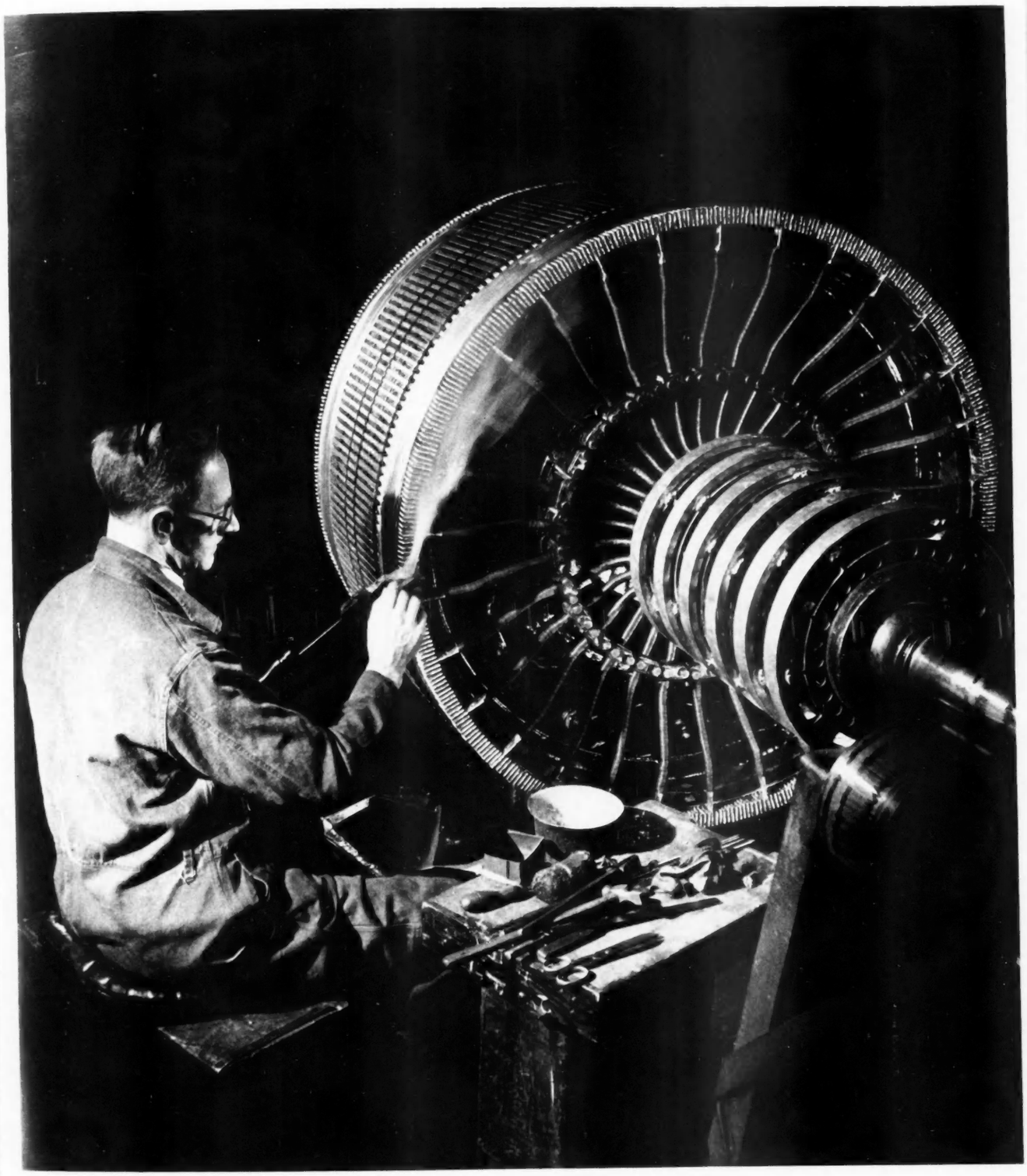
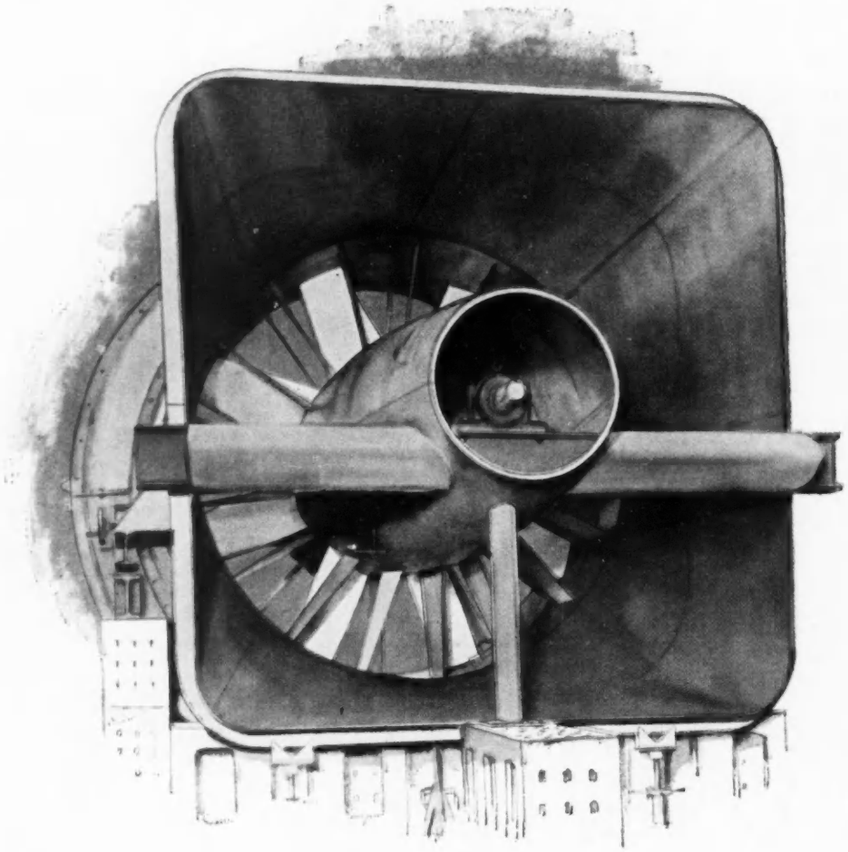


SOLDERING ARMATURE JOINTS



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THE COLOUR PHOTOGRAPH ABOVE shows erection proceeding in Davy-United's Darnall Works on a new 5-Stand Tandem Cold Strip Mill, with ten 100-ton housings, for the Ebbw Vale Works of Richard Thomas & Baldwins Ltd., wherein it is now rolling 38" wide steel strip at the rate of 5,000 feet per minute. Through planned works expansion at a cost of more than £2 million, Davy-United have now provided manufacturing capacity in this country capable of undertaking the largest mill contracts ever likely to be envisaged, capacity which is effectively helping to reduce Britain's previous heavy dollar dependency for plant of this type.

Builders of capital equipment for the metals industries

DAVY-UNITED

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PATENT HIGH-PRECISION COUNTER-BALANCE CHAINS

These chains have been designed expressly to meet the need for a range of high-duty counter-balance chains.

The range is based upon two standard heat-treated high-tensile link-plates. The larger plates, milled to conform with the pulley profile, are ground on the sides, and according to the number of plates in the breadth of the links, the breaking loads are 23 tons, 17 tons and 13 tons.

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All the chains are non-kinking.

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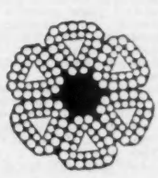

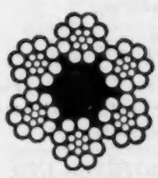

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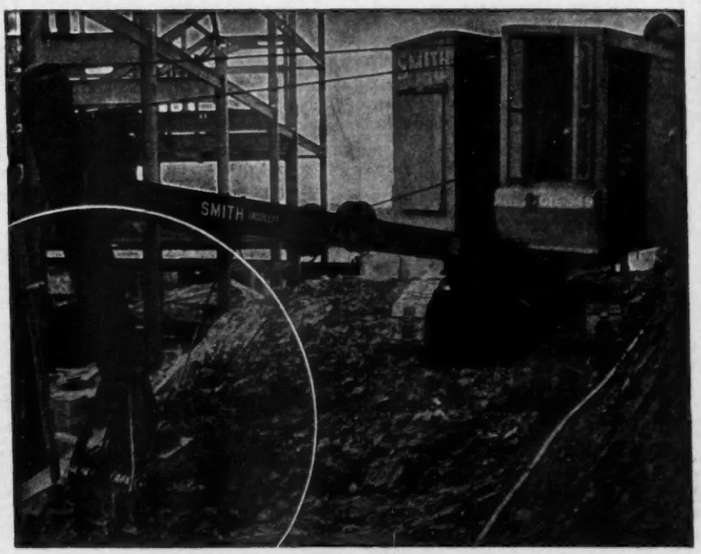

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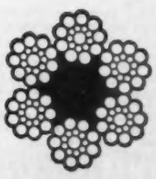

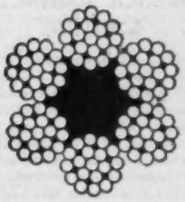

CLASSIFIED ADVERTISEMENTS SECTION.

For all advertisements classified under the headings of Tenders, Appointments Open, Situations Wanted, Patent Agents, Partnerships, Wanted, &c., Auction Sales, Publications For Sale, Miscellaneous and Public Notices, &c., the charge will be 12s. for the first four lines or under and 3s. per line up to one inch. When an advertisement measures an inch or more, the charge will be at the rate of 36s. per inch. 5% allowed on 6, 10% on 13, 15% on 26 and 20% on 52 Weekly insertions. If use is made of a box number the extra charge is 2s. per insertion with the exception of advertisements appearing under Situations Wanted. Prospectuses and Notices of Company Meetings £25 per column. Copy instructions must be in our hands first post Monday for the following Friday's issue. Address to the Manager, ENGINEERING LTD., 35 and 36, Bedford St., Strand, W.C.2 Inclusion of advertisements must be dependent on space being available.

PUBLIC NOTICE.

ROYAL CORPS OF NAVAL CONSTRUCTORS

SCHOOLS ENTRY.

A COMPETITION for a new form of entry into the Royal Corps of Naval Constructors will be held in July, 1956.

Accepted candidates will be established as Probationers in the R.C.N.C. and will undergo a 2-year course of training at the R.N. Engineering College, Manadon, and in H.M. Dockyard, Devonport, followed by a 3-year course at the R.N. College, Greenwich.

Candidates must be aged between 18 years and 19 years 6 months inclusive on 1st September, 1956.

Candidates with the General Certificate of Education will be required to have passed at Advanced Level in at least Pure Mathematics, Applied Mathematics and Physics, and to produce evidence of general education at Ordinary level.

Candidates with the Scottish Leaving Certificate will be required to have higher grade passes in Physics and Mathematics and at least lower grade passes in English and a language other than English and two other subjects (preferably mathematical).

Candidates from schools in Northern Ireland will be required to produce a certificate from the Ministry of Education in Northern Ireland showing a comparable standard to that above.

The work of the R.C.N.C. covers all aspects of design construction and repair of H.M. Ships Members undertake to serve wherever required at Admiralty Headquarters and outports in the United Kingdom, and at Royal Dockyards at Home and Abroad. The Head of the R.C.N.C. is the Principal Technical Adviser to the Board of Admiralty.

Total pay for probationers will commence at £313 10s. 0d. p.a. at the R.N.E.C. at age 18, rising to £575 at Greenwich at age 23. The successful probationer can expect appointment as Assistant Constructor usually at age 23 with total pay (London) of £805. Promotion to constructor is at about age 30 with total pay of £1399 rising in 9 years to £1750. Promotion to higher ranks with top salary £3500 is by selection.

Full particulars may be obtained from the SECRETARY OF THE ADMIRALTY, C.E. BRANCH II, EMPIRE HOTEL, BATH, to whom final applications must be submitted by 15th June, 1956. K 999

EDUCATIONAL.

FREE. Brochure giving details of courses in Mechanical and Production Engineering, Draughtsmanship, etc., for the A.M.I.Mech.E., A.M.I.P.E., City and Guilds and other Professional examinations. E.M.I. INSTITUTES, DEPT. EG. 30, LONDON, W.4. (ASSOCIATED WITH H.M.V.) G 619

FELLOWSHIP.

RESEARCH FELLOWSHIP TENABLE AT THE BUILDING RESEARCH STATION

Applications are invited from mechanical engineers for a Research Fellow to work as a member of a team studying problems associated with the delivery to building sites of bricks in packages which can be handled with the minimum of manpower. The Fellowship will be for a period of three years and is sponsored by the Brick Development Association, Limited.

Candidates should hold a degree in engineering and be corporate members of the Institution of Mechanical or Civil Engineers. Some practical experience preferably in design of materials handling or processing plant, or equivalent, is desirable, and knowledge of estimating and operational research experience would be an advantage.

Starting salary may, depending on experience, be up to £1000 per annum. It is envisaged that the successful candidate will be offered an appointment by the British Ceramic Research Association after the completion of the three-year tenure of the Fellowship.

Applications, which should give the names of two referees, should be addressed to BRICK DEVELOPMENT ASSOCIATION LIMITED, c/o DIRECTOR OF BUILDING RESEARCH, BUILDING RESEARCH STATION, GARSTON, WATFORD, HERTS., to be received not later than 15th May. L 373

EXPERIMENTAL WORK.

RESEARCH ENGINEERS LIMITED,

Northampton Grove, Canonbury, London, N.1. Canonbury 4244/5/6. We have over 25 years' experience of experimental work and prototypes. We design, develop and manufacture special purpose and labour saving machines, all at the above address. Our range is from the smallest scientific instruments to 3- or 4-ton machines. After a prototype machine has been made and found satisfactory we can manufacture as many as are required. G 656

COURSES.

UNIVERSITY OF BIRMINGHAM.

DEPARTMENT OF MECHANICAL ENGINEERING.

GRADUATE SCHOOL OF THERMODYNAMICS AND RELATED SUBJECTS.

A COURSE available in the above School provides facilities for the study, at advanced level, of modern developments in Thermodynamics and allied subjects and of their applications in the general field of the heat engine. The normal entrance qualifications are an Honours Degree in Mechanical Engineering together with a minimum of two years of practical experience in industry. On completion of the twelve-month course commencing on 1st October, 1956, and including nine months attendance at the University, successful candidates qualify for the award of the degree of Master of Science. In special circumstances applications may be considered from graduates in other Sciences who hold satisfactory alternative qualifications. In the latter case it will usually be necessary for two years to be spent in completing the course. The award to successful non-graduate engineers is the Diploma of Graduate Studies.

The inclusive fee for the course of study is £71 1s. In certain cases where a student is not sponsored by an employer, the University may consider applications for the remission of this fee and, where essential, for the grant of a maintenance allowance during the period of attendance.

Further particulars and application forms may be obtained from the Registrar, The University, Birmingham, 15. Applicants are advised to apply before 1st August but applications received after this date may be considered if places are available.

G. L. BARNES,
Secretary. L 248

The University,
Birmingham, 15.

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DESIGN CAPACITY AVAILABLE

We have teams available to undertake design, detailing and development in the following fields:

Mechanical Engineering
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Special Machines and Projects
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Mechanical Handling
Plant Layout
Production Tooling Etc.

The conception, design and development of **"BLUEBIRD"** was a special project undertaken by

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G 661

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ACCURATE SCALE MODELS.

Industrial Plant, Ships, Machinery, Civil Engineering, etc.

Static or working models for exhibition, advertising or instructional purposes. Enquiries invited and estimates submitted.

C. A. MILLS, 18, MANOR RD., RUISLIP, MIDDLESEX. Tel.: RUISLIP 4374. G 662

FOR HIRE.

LATTICE STEEL ERECTION MASTS (light and heavy) 30 ft. to 150 ft. high, for immediate hire. —BELLMAN'S, 21, Hobart House, Grosvenor Place, S.W.1. G 72

DESIGN AND DEVELOPMENT.

The "Mekydro" Power Transmission.

J. STONE & COMPANY (DEPTFORD), LTD., announce that they have acquired the exclusive rights to manufacture and sell in the United Kingdom the "Mekydro" Power Transmission for all purposes, from Messrs. Maybach - Motorenbau, G.m.b.H.

The Mekydro Power Transmission has been successfully developed by the Maybach Co. as a result of their wide experience in designing and supplying power transmissions for traction purposes over many years, and both diesel locomotives and railcar trains embodying the Mekydro Power Transmissions are being increasingly used by European Railways.

J. STONE & COMPANY (DEPTFORD), LTD., would be pleased to supply full technical and performance details on request.

J. Stone & Co. (Deptford) Ltd.
London, S.E.14.
L 423

PUBLIC APPOINTMENTS.

ADMIRALTY.
ROYAL NAVAL SCIENTIFIC SERVICE.

DRAUGHTSMEN required in Admiralty Research and Development Establishments in London (Teddington area), Portsmouth, Weymouth, and Baldock (Herts) for the design of experimental apparatus needed for fundamental research or for fitting in H.M. ships. Experience is necessary in any of the following classes of equipment: light to medium electrical, electro-mechanical, precision mechanical and electronic.

Candidates must be British aged 21 years or over, with at least 3 years' practical workshop training and, preferably, with drawing office experience and/or possession of the O.N.C. or equivalent.

Appointments unestablished, but opportunities will occur to compete for established posts and for promotion.

Starting pay (London rate), £463 10s. per annum (aged 21), £635 (aged 28) rising by 4 increments to £725 per annum; slightly less in the Provinces.

Apply stating age, training, experience and qualifications to ADMIRALTY, SANCTUARY BUILDINGS (ROOM 151), GREAT SMITH STREET, LONDON, S.W.1. G 636

LONDON COUNTY COUNCIL.

ARCHITECT'S DEPARTMENT.

Vacancies for

ENGINEERING ASSISTANTS (up to £818) and **ENGINEER GRADE III** (up to £987) in the Structural Engineering Division. Work includes steelwork and reinforced concrete design and detailing for Council's buildings. Particulars and application forms from ARCHITECT (AR/EK/SE/1) THE COUNTY HALL, S.E.1. (1278). G 573

LONDON ELECTRICITY BOARD.

CIVIL/STRUCTURAL ENGINEERING ASSISTANTS AND DRAUGHTSMEN.

Applications are invited for the above positions in the Construction Branch of the Chief Engineer's Department in Central London.

Conditions of service are in accordance with the National Joint Board agreement, Schedule "D," and salaries are inclusive of London Allowance.

Applicants for the positions of Assistants should have experience in the design and detailing of reinforced concrete for foundations, framed buildings, etc., or in the design and detailing of structural steelwork for buildings, etc. Salary within Grade 5 = £735 to £840 per annum.

Applicants for the positions of Draughtsmen should have experience in the preparation of drawings for either reinforced concrete or structural steelworks or building work. Salary within Grade 6 = £588 to £714 per annum.

Application forms obtainable from PERSONNEL OFFICER, 46, NEW BROAD STREET, LONDON, E.C.2. Please quote ref.: PER/V/2003/FF. L 85

CENTRAL ELECTRICITY AUTHORITY.
SOUTH WESTERN DIVISION.

SENIOR ENGINEERING DRAUGHTSMEN (MECH.) required in the Generation Construction Department, Feeder Road, Bristol.

Superannuation Scheme. Salary, N.J.B. Schedule "D," Grade 5, £700-£800, or Grade 4, £810-£910, according to experience and qualifications.

Sound technical training and Drawing Office experience required. Knowledge of Power Station equipment and layout an advantage.

Applications on Form A.E.6/ACT, obtainable from the DIVISIONAL SECRETARY, 26, OAKFIELD ROAD, BRISTOL, 8, should be completed and returned by 19th May, 1956. L 471

BARROW-IN-FURNESS EDUCATION COMMITTEE.

CENTRAL COLLEGE OF FURTHER EDUCATION.

Required in September, 1956, a

FULL-TIME ASSISTANT, GRADE B, TO TEACH MECHANICAL ENGINEERING SUBJECTS to Higher National Certificate and Diploma level. Applicants should possess graduate qualifications and have had good industrial experience; they should be able to offer at least one of the following subjects to advanced level:—Applied Mathematics, Strength of Materials or Theory of Machines. Burnham Scale, for Grade B Assistants, viz., £525 by £25 to £820, with additions in respect of approved qualifications and training, and increments for suitable industrial and teaching experience. Application forms, obtainable by sending a stamped addressed foolscap envelope to the Chief Education Officer, John Whinnerah Institute, Barrow-in-Furness, should be returned as soon as possible.

LAWRENCE ALLEN,
TOWN CLERK.

TOWN HALL,
BARROW-IN-FURNESS. L 462

NATIONAL COAL BOARD—
NORTH EASTERN DIVISION.

A WORKSHOP MANAGER is required by the National Coal Board, No. 2 (Doncaster) Area, for the Central Engineering Workshops, Carcroft, now in the course of construction. The works will ultimately employ 200 men and will be engaged chiefly on the cyclic repair of mining machinery and plant, together with a manufacturing load of special equipment and plant mostly of the one off or small batch basis.

The works comprise a mining machinery reconditioning shop, plate and construction shop, blacksmith and heat treatment shop, locomotive overhaul shops, machine shops, electrical and trailing cable repair shops, and an apprentice training centre which cover some 72,000 sq. ft. of floor space.

Applicants should have a full engineering background, and should have held executive positions in works of the above or similar type.

They should be able to produce evidence of the successful application of modern production, planning and industrial managerial organisational methods in all their aspects.

Only applicants with the above experience and able to substantiate it should apply for this important post, for which the salary will not be less than £1000 per annum.

Applications, stating age, experience, qualifications and positions held, in chronological order, should be sent to the AREA ADMINISTRATIVE OFFICER, NATIONAL COAL BOARD, NO. 2 (DONCASTER) AREA, ST. GEORGE'S, THORNE ROAD, DONCASTER. Closing date for applications 12th May, 1956. L 380

BATTERSEA POLYTECHNIC,
BATTERSEA PARK ROAD, LONDON, S.W.11

Applications are invited from Graduates of a British University for a

GRADE B LECTURESHIP IN CIVIL ENGINEERING. Salary, £621 or £633 by £25 to £928, plus £30 for a good honours degree, a training allowance and increments for experience, less statutory deductions.—Further particulars from the CLERK TO THE GOVERNING BODY, by whom applications should be received not later than 11th May, 1956. L 399

STAFFORDSHIRE COUNTY COUNCIL
EDUCATION COMMITTEE.

COUNTY TECHNICAL COLLEGE, STAFFORD.

Principal: A. TORKINGTON, B.Sc., M.I.Mech.E., A.M.I.P.E.

Applications are invited for the post of

LECTURER TO TEACH MECHANICAL ENGINEERING SUBJECTS to Higher National Certificate and Degree standard. Ability to teach Metallurgy to Higher National Certificate level would be a recommendation.

Candidates should possess a University degree and have industrial and teaching experience. The appointment is to commence on 1st September, 1956.

The salary will be in accordance with the Burnham Scales for Teachers in Establishments for Further Education, Lecturer Scale, viz., £965 by £25 to £1065.

A form of application and further particulars may be obtained from the undersigned on receipt of a stamped addressed foolscap envelope. Completed forms must be returned by 11th May, 1956.

J. H. P. OXSPRING,
DIRECTOR OF EDUCATION.

DEPT. F.E.,
COUNTY EDUCATION OFFICE,
STAFFORD. L 375

METROPOLITAN WATER BOARD

have the following vacancies on the
PERMANENT PENSIONABLE STAFF.

ASSISTANT ENGINEERS

(Civil, Mechanical and Electrical)
Salary scale, £856-£1054 per annum.
Applicants must be corporate members of the Institution of Civil Engineers, Mechanical Engineers or Electrical Engineers and must have had sound engineering experience. (Ref. 5.)

ENGINEERING ASSISTANTS

(Civil, Mechanical and Electrical).
Salary scale, £552-£823 per annum.
Applicants must be corporate members of one of the above-mentioned Institutions or have passed or be exempted from passing Sections A and B (or Final Parts I and II) of the examination of the appropriate Institution. (Ref. 6.)

SENIOR DRAUGHTSMEN

(Civil Engineering).
Salary scale, £765-£889 per annum.
Applicants must have had responsible experience in the design of civil engineering works and must possess a General School Certificate or have passed an equivalent examination. (Ref. 7.)

JUNIOR DRAUGHTSMEN & DRAUGHTSWOMEN

(Civil, Mechanical, Electrical, Architectural and Map and Plan).
Salary scale: Age 16, £237, 17, £275, 18, £322, 19, £356, 20, £391, 21, £425, rising by annual increments to a maximum of £630 per annum at age approximately 29.
Applicants must possess a General Certificate of Education with passes in English, Mathematics and three other approved subjects, or a General School Certificate, or have passed an equivalent examination. (Ref. 8.)

FOR SOME OF THE ABOVE-MENTIONED VACANCIES HOUSING ACCOMMODATION MAY BE AVAILABLE AT A REASONABLE RENTAL.

Commencing salaries for all appointments will be according to age, qualifications and experience. Office hours 9 a.m. to 4.30 p.m. (Mon., 5 p.m.). Saturday, 9 a.m. to 12 noon. Saturday morning leave according to service. Social and sports club facilities. Staff restaurant.

Forms of application may be obtained from the undersigned. The appropriate reference should be quoted.

S. D. ASKEW,
CLERK OF THE BOARD.

OFFICES OF THE BOARD, New River Head, Rosebery Avenue, E.C.1. L 459

THE UNIVERSITY OF MANCHESTER.

OSBORNE REYNOLDS RESEARCH FELLOWSHIP IN ENGINEERING.

Applications are invited for the above Fellowship, of the value of not more than £600 for one year with a possible extension for a maximum of one further year. Candidates should have had experience of research in hydraulics and should be capable of independent work. Preference will be given to candidates who would be interested to work on bed movement in hydraulic models under the general direction of the Beyer Professor of Engineering, but consideration will be given to candidates who suggest other related projects. The person appointed, if suitably qualified, would be eligible for admission as a candidate for the degree of Ph.D. Further particulars and forms of application may be obtained from the REGISTRAR, THE UNIVERSITY, MANCHESTER, 13, to whom applications should be sent not later than June 2nd, 1956. L 400

NATIONAL COAL BOARD—NORTH EASTERN DIVISION.

Applications are invited for the vacancy of **CIVIL ENGINEERING ASSISTANT** in No. 3 (Rotherham) Area.

The successful applicant will be required to assist on design, preparation of contract documents and administration of contracts for varied and interesting heavy civil engineering, involving reinforced concrete and steelwork, general building construction, railways, roads, drainage, etc.

Salary will depend on qualifications and experience and will be between £650 and £900.

Application forms obtainable from the ADMINISTRATIVE OFFICER, WATH-ON-DEARNE, NR. ROTHERHAM, YORKS., must be returned within 16 days of this advertisement. L 387

STAFFORDSHIRE EDUCATION COMMITTEE.

COUNTY TECHNICAL COLLEGE, WEDNESBURY.

DEPARTMENT OF ENGINEERING.

Applications are invited from suitably qualified persons for the following posts :—

1. **SENIOR LECTURER IN PRODUCTION ENGINEERING** with special reference to Metrology and Machine Tools and/or Jig and Tool Design. Some experience of applied research would be an additional qualification.
2. **SENIOR LECTURER IN MECHANICAL ENGINEERING,** who should offer as main subjects, Theory of Machines and/or Strength of Materials. Some experience of Management subjects would be an additional qualification.
3. **ASSISTANT, GRADE B,** for general mechanical engineering subjects to A.I. standard.

Salaries in accordance with the Burnham Technical Scale, namely, Senior Lecturer, £1065 by £25 to £1215, Assistant, Grade B, £525 by £25 to £820.

Further particulars and form of application, returnable by 19th May, may be obtained from the undersigned on receipt of a stamped addressed foolscap envelope. Applicants should state for which post forms are required.

J. H. P. OXSPRING,
DIRECTOR OF EDUCATION.

DEPT. F.E.,
COUNTY EDUCATION OFFICES,
EARL STREET,
STAFFORD. L 388

STAFFORDSHIRE EDUCATION COMMITTEE.

COUNTY TECHNICAL COLLEGE, WEDNESBURY.

DEPARTMENT OF METALLURGY.

Applications are invited from suitably qualified applicants for the following posts in the above Department :—

LECTURER,
ASSISTANT, GRADE B.

The Department is one of the best-equipped in the country and conducts work to post-graduate level.

Salary will be in accordance with the current Burnham Award as under :—
Lecturer: £965 by £25 to £1065 per annum.
Assistant, Grade B: £525 by £25 to £820 per annum.
Plus appropriate allowances for training and experience.

Further particulars and form of application may be obtained from the undersigned on receipt of a stamped addressed foolscap envelope. Applicants should state for which post forms are required.

Completed forms of application should be returned not later than 12th May.

J. H. P. OXSPRING,
DIRECTOR OF EDUCATION.

DEPT. F.E.,
COUNTY EDUCATION OFFICES,
EARL STREET,
STAFFORD. L 389

SOUTH AFRICAN IRON AND STEEL INDUSTRIAL CORPORATION, LIMITED,

(ISCOR).

VACANCIES FOR GRADUATES OR HOLDERS OF TECHNICAL DIPLOMAS IN VARIOUS BRANCHES OF ENGINEERING AND INDUSTRIAL SCIENCE.

Applications are invited from the following categories of Engineering Staff for employment in the Corporation's Works in South Africa, viz.,

PRODUCTION.

GRADUATES or holders of Technical Diplomas in various branches of Engineering and the Industrial Sciences, who have had approximately five years' practical experience on the production side of the Iron and Steel Industry, in the following individual sections or combinations thereof:—

(1) Rolling Mills.
(2) Steel Melting Plants.
(3) Coke Ovens and By-Products Plants
(4) Blast Furnaces.

ENGINEERING.

GRADUATES or holders of Technical Diplomas in Mechanical, Electrical and Civil Engineering who have had approximately five years' practical experience in maintenance and/or construction in the Iron and Steel and Heavy Engineering Industry.

SALARIES.

Salaries will be discussed with individual applicants at personal interviews, which will be held by an official of the Corporation who will be visiting Europe after June, 1956.

COST OF LIVING ALLOWANCE AND LEAVE BONUS.

In addition to basic salary, a cost-of-living allowance is paid, as well as a leave bonus equal to one month's basic salary when employees proceed on not less than 15 consecutive days' vacation leave in any anniversary year.

GENERAL CONDITIONS OF SERVICE.

Membership of the Corporation's Contributory Pension Fund and of the Iscor Medical Benefit Fund is compulsory.

Successful applicants will be required to satisfy the Corporation's Medical Officer as to the state of their health and appointments will further be subject to the Corporation's usual conditions of employment.

Applications, stating age, qualifications, previous experience and marital state must be addressed to the undersigned at 723-737, THE ADELPHI, LONDON, W.C.2.

B. W. HARDING,
LONDON REPRESENTATIVE
L 381

The ASME Handbook

Sponsored by the American Society of Mechanical Engineers

JUST PUBLISHED

ENGINEERING TABLES

Edited by Jesse Huckert
Professor of Mechanical Engineering, Ohio State University

This reference manual for design engineers forms the third volume of the ASME Handbook on the properties and characteristics of metals. It is a collection of up-to-date tables, generally recognized as standards, which are often needed by engineers and technicians but which are not commonly found in handbooks.

Tables concerned with the design of specific parts are grouped together. A table of involute functions, methods for finding the loads on ball bearings, and data on bars and tubes suitable for re-working into gears, levers, shafts or screws are included. Many of the tables are cross-referenced for easy use in design calculations. The details in these fifteen sections supplement the designer's knowledge of standards for shape and dimension and the information given in the companion volume, *Metals Engineering—Design*. The properties of metals are described in the other volume on *Metals Properties*.

In general a single primary source, such as the American Standards Association, is given for each table. This indicates the reliability of the data and serves as a reference for additional information.

704 pages 90s

ALREADY AVAILABLE

METALS PROPERTIES
455 Pages 82s 6d

METALS ENGINEERING—DESIGN
450 Pages 75s

McGraw-Hill Publishing Company

COUNTY BOROUGH OF ROTHERHAM.

EDUCATION COMMITTEE.

ROTHERHAM TECHNICAL COLLEGE.

Principal: G. E. COOKE, M.A. (Cantab.), A.M.I.C.E.

DEPARTMENT OF MECHANICAL, PRODUCTION AND CIVIL ENGINEERING.

Applications are invited from suitably qualified persons for the undermentioned posts, to commence duties on 1st September.

1. **SENIOR LECTURER IN MECHANICAL ENGINEERING** to teach to Higher National Diploma (Sandwich) and Degree standard.
2. **LECTURER IN PRODUCTION ENGINEERING** to teach to Higher National Certificate standard in at least two of the subjects —Metrology, Machine Tools, Workshop Technology, Jig and Tool Design.

Candidates for these posts should have had appropriate industrial and teaching experience.

Salary will be in accordance with the Burnham Technical Report 1954—
Senior Lecturer : £1065 by £25 to £1215.
Lecturer: £965 by £25 to £1065.

The starting position on the scale will be determined by previous teaching and/or industrial experience.

Application forms, which should be returned within 14 days of the appearance of this advertisement, and further particulars, may be obtained from the undersigned.

R. BLOOMER,
Director of Education.

Education Offices,
Rotherham. L 368

STRUCTURAL ENGINEER urgently required. Senior Assistant experienced in design of steelwork for buildings. Must be A.M.I.Struct.E., or equivalent. Salary, APT. VI, £880-£1080.

Alternate Saturdays free. Canteen facilities.

Application forms may be obtained from the COUNTY ARCHITECT, BISHOPGARTH, WESTFIELD ROAD, WAKEFIELD, and should be returned not later than the first post on May 31st, 1956. L 442

COVENTRY TECHNICAL COLLEGE.

Applications invited for following full-time teaching posts from September, 1956, mainly arising from increased establishment. Candidates should be graduates or hold good technical qualifications and where appropriate should have had industrial and/or teaching experience:—

MECHANICAL ENGINEERING DEPARTMENT.

LECTURERS (3 VACANCIES)—Mechanical Engineering, Production Engineering and Work Study, respectively.

ASSISTANTS GRADE B (4 VACANCIES), GRADE A (3 VACANCIES) for National Certificate and Trades Courses in Mechanical and Production Engineering.

Burnham Technical Scale Salaries at present:—
LECTURERS ... ... £965 by £25 to £1065 (Men)
ASSISTANTS GRADE B £525 by £25 to £820 (Men)
ASSISTANTS GRADE A £450 by £18 to £725 (Men)

Plus additions for qualifications and training; commencing salary dependent on previous experience.

Application forms and further particulars from DIRECTOR OF EDUCATION, NEW COUNCIL OFFICES, COVENTRY. L 371

Classified Advertisements continued on Page 4

NORTHAMPTON POLYTECHNIC, ST. JOHN STREET, LONDON, E.C.1.

Applications are invited for the following post in the Civil and Mechanical Engineering Department. **LECTURER IN AERONAUTICAL ENGINEERING,** to be mainly concerned in the teaching of AERODYNAMICS in Degree and Higher National Certificate courses. The appointment will date from 1st September.

Salary scale : £1001 by £25 to £1113.

Further particulars and forms of application are obtainable from the Secretary, to whom applications should be sent within 14 days of the appearance of this advertisement.

J. E. RICHARDSON, Ph.D., B.Eng., M.I.E.E., A.M.I.Mech.E.
PRINCIPAL. L 407

SPRINGFIELD HOSPITAL ANNEXE, KINGSTON ROAD, NEW MALDEN, SURREY. (302 female psychiatric beds.)

ASSISTANT ENGINEER (RESIDENT) to supervise and participate in the maintenance and operation of engineering services under direction of Supt. Engineer. Applicants must have completed an apprenticeship in mechanical engineering or have otherwise acquired a sound practical training in mechanical engineering. Preference given to holder of Ordinary National Certificate in Mechanical Engineering which includes Heat and Heat Engines as a subject and preferably has an endorsement in the principles of electricity, or a Second Class Certificate of Competency in Marine Engineering (or the equivalent Naval Certificate). Salary, £525 by £20 (1) by £25 (4) to £645 plus London Weighting. Superannuable. Flat available.—Apply, stating age, qualifications and experience to GROUP SECRETARY, SPRINGFIELD HOSPITAL, UPPER TOOTING, S.W.17. L 408

BARBADOS.

DISTRIBUTION ENGINEER.

NATURAL GAS CORPORATION.

Appointment on Agreement for 3 years in the first instance. Salary, £1700-£2000 p.a. Assisted passages. Generous leave on satisfactory completion of engagement. Low Income Tax.

Candidates should be Members of Institution of Gas Engineers, preferably about 45 and have had administrative and executive experience.

DUTIES.—Engineering design and supervision of construction of modern natural gas distribution system for about 2000 customers. Engineering supervision of operation, maintenance and expansion of natural gas utility, comprising production, transmission, distribution and utilization.

Apply to DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, LONDON, S.W.1. Give details of age, qualifications and experience. Quote—BCD. 501/28/01/D5. L 391

ROYAL AIRCRAFT ESTABLISHMENT TECHNICAL COLLEGE, FARNBOROUGH, HANTS.

Applications are invited for the following vacancies in the above selective day College.

POST 1. LECTURER IN ENGINEERING DESIGN.
POST 2. LECTURER IN MECHANICAL ENGINEERING.
POST 3. LECTURER IN PRODUCTION ENGINEERING.
POST 4. ASSISTANT LECTURER B IN ELECTRICAL ENGINEERING.
POST 5. ASSISTANT LECTURER B IN MECHANICAL ENGINEERING.
POST 6. ASSISTANT LECTURER B IN PRODUCTION ENGINEERING.
POST 7. ASSISTANT LECTURER B IN GENERAL ENGINEERING SUBJECTS.
POST 8. DEMONSTRATOR IN ELECTRICAL ENGINEERING AND PHYSICS.
POST 9. DEMONSTRATOR IN MECHANICAL ENGINEERING.

Candidates should hold University degrees, or equivalent, and preferably have had industrial and/or teaching experience.

The successful candidates for Posts 1 to 7 will be required to assist in courses leading to B.Sc. (Eng.), Higher National Certificates and final City and Guilds Certificates. In Posts 8 and 9 the successful candidates will be required to assist in the organisation, preparation and control of work in the laboratories. Facilities for further study and/or research may be available.

The salaries payable are in accordance with the Burnham Scale for Teachers in Technical Colleges and are subject to the Teachers' Superannuation Acts. For Lecturer the scale is £965 by £25 to £1065. For Assistant Lecturer B the scale is £525 by £25 to £820 with allowances for qualifications (£90 for a good degree) and experience (£18 per year). For Demonstrator the scale is £450 by £18 to £725 with allowances similar to Assistant B. These scales are at present being reviewed by the Burnham Committee and it is hoped that they will be increased.

Details and Application Forms from PRINCIPAL, to whom completed forms should be returned within fourteen days of this notice. L 360

NORTH THAMES GAS BOARD.

SENIOR DRAUGHTSMEN are required in the CHIEF ENGINEER'S DRAWING OFFICE at WESTMINSTER, S.W.1, for :—

(*a*) the design and detailing of Civil Engineering, Foundations and Structural Work mainly in reinforced concrete associated with Gas Manufacturing Plant.

(*b*) the design and layout of general process plant and all associated structural steelwork.

Candidates should preferably be Corporate Members of the Institutions of Civil, Structural or Mechanical Engineers. Starting salaries within the range £850 to £1000 per annum, according to age, qualifications and experience. The successful candidates will be required to join the staff pension scheme.

Applications, giving age and full particulars, should be sent to the STAFF CONTROLLER, NORTH THAMES GAS BOARD, 30, KENSINGTON CHURCH STREET, W.8, quoting reference 666/314. L 440

NORTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD.

The Board are engaged on a number of new building and engineering projects, including a new hospital at Welwyn, and the following staff are required to fill a number of newly-created posts on the establishment of the Regional Engineer.

ASSISTANT ENGINEERS—ELECTRICAL, MECHANICAL, HEATING AND VENTILATING.

Applicants must be at least (*a*) Graduate members of the Institution of Electrical Engineers, and have passed the Institution examination (lately the Associate membership examination) or recognised exempting examinations; or (*b*) Graduate members of the Institution of Mechanical Engineers, and have passed Sections A and B of the Associate membership examination, or recognised exempting examinations; or (*c*) Graduate members of the Institution of Heating and Ventilating Engineers, and have passed the Associate membership examination, or recognised exempting examinations.

Salary scale: £640 by £25 (4) by £30 (4) by £35 (2) to £930, plus £20-£40 London Weighting.

ENGINEERING ASSISTANTS

Applicants must have O.N.C. or other approved qualification in appropriate engineering subjects.

Salary scale: £480 (age 21 and over) by £20 (7) by £25 (2) to £670, plus £20-£30 London Weighting.

Posts are subject to Whitley Council conditions and are superannuable. Starting salaries may be above minimum having regard to extent of experience since obtaining appropriate qualifications.

Apply, stating which post, and giving age, qualifications (with dates) and experience, together with the names and addresses of two referees, to SECRETARY, NORTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD, 11a, PORTLAND PLACE, LONDON, W.1, by 19th MAY. L 383

SENIOR ENGINEER required by N.C.B.'s CENTRAL ENGINEERING ESTABLISHMENT, STANHOPE BRETBY, NR. BURTON-ON-TRENT, for work including design of test rigs, and conduct of trials for proving and acceptance of materials and equipment used in the coal industry. Corporate Membership of I.M.E., and experience in design and operation of test rigs and experimental field trials, are required. Appointment (superannuable) within range £1122 to £1650, according to qualifications and experience.

Write, with full particulars of age, education, qualifications and experience, to NATIONAL COAL BOARD, STAFF DEPT., HOBART HOUSE, LONDON, S.W.1, marking envelope S8/262, before 17th May, 1956. L 365

LIVERPOOL REGIONAL HOSPITAL BOARD.

Applications invited for permanent pensionable appointment of

ASSISTANT ENGINEER (Mechanical, Heating and Ventilating) in the Regional Engineer's Department.

Applicants should have served a recognised engineering apprenticeship; be Graduates of the Institution of Mechanical Engineers or Corporate Members of the Institution of Heating and Ventilating Engineers. A wide experience of heating, ventilating, domestic hot water plants and pumping plants and a knowledge of laundry and kitchen plant will be an advantage.

The duties include carrying out surveys, preparation of drawings, estimates and specifications, particularly for heating and ventilation schemes.

Salary scale, £640-£930. Commencing salary dependent on age and experience.

Applications, stating age, qualifications, experience, present and previous appointments, with names and addresses of three referees (two technical), to me at 19, JAMES STREET, LIVERPOOL, 2, not later than 25th May, 1956.

VINCENT COLLINGE,
Secretary to the Board. L 362

TECHNICAL CLASS GRADE II (ASSISTANT TECHNICAL COST OFFICERS) required by MINISTRY OF SUPPLY. Posts are based London but considerable travel necessary (subsistence allowance payable). Prospects of establishment. Candidates must have served recognised engineering apprenticeship and had good experience in rate-fixing, planning and prime cost estimating in works manufacturing high precision engineering products. Good machine shop experience desirable. Possession of O.N.C., appropriate City and Guilds Final Certificates or equivalent technical qualification an advantage. Duties include preparing detailed prime cost estimates for pricing of Government contracts. Salary: Within £756 (age 30)-£898 p.a. —Application forms from BY.82, LONDON APPOINTMENTS OFFICER, MINISTRY OF LABOUR AND NATIONAL SERVICE, 1-6, TAVISTOCK SQUARE, W.C.1. L 361

KENT COUNTY COUNCIL require

AREA MAINTENANCE ENGINEER with good practical experience in the design and maintenance of electrical and/or heating, hot and cold water and cooking installations in buildings. Salary within Scales £710-£885 or £640-£765 according to experience. Application forms from COUNTY ARCHITECT, SPRINGFIELD, MAIDSTONE. Closing date, 15th May, 1956. L 447

AUSTRALIA.

UNIVERSITY OF MELBOURNE.

Applications are invited for the position of **LECTURER OR SENIOR LECTURER IN AGRICULTURAL ENGINEERING** (hydrology, hydraulics, irrigation, drainage, soil erosion). Applicants should possess a University degree in Civil and/or Agricultural Engineering, and have had experience in soil-water engineering, and have some interest in structures and building planning.

The salary will be from £A1300 to £A1800 per annum for a Lecturer, or £A1850 to £A2150 for a Senior Lecturer, depending on qualifications and experience. Superannuation is similar to F.S.S.U.

Further particulars and information as to the method of application may be obtained from the SECRETARY, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36, GORDON SQUARE, LONDON, W.C.1.

The closing date for the receipt of applications, in Australia and London, is 30th JUNE, 1956. L 448

NORTH STAFFORDSHIRE TECHNICAL COLLEGE, STOKE-ON-TRENT.

Principal: H. W. WEBB, O.B.E., D.Sc.

Applications are invited for the post of full-time **ASSISTANT LECTURER (GRADE B) IN MECHANICAL ENGINEERING.**

Applicants should preferably possess a degree or equivalent qualification and be capable of teaching to Higher National Certificate standard. Ability to teach one or more of the subjects Strength of Materials, Mechanics of Machines, Mechanics of Fluids, or Applied Thermodynamics, to degree standard would be an additional recommendation.

Salary according to the Burnham Technical Scale for Assistants, Grade B (at present £525 by £25 to £820), with full additions for training, graduate qualification and experience.

Applications, giving details of qualifications, training and experience, together with the names of two referees, should be sent to the PRINCIPAL as soon as possible.

H. DIBDEN,
CLERK TO THE GOVERNORS L 402

CENTRAL ELECTRICITY AUTHORITY. MIDLANDS DIVISION.

FOURTH ASSISTANT ENGINEER (CIVIL) is required in the Construction Department at Hams Hall "C" Power Station. N.J.B. service conditions, superannuable appointment, salary within Schedule "B" Grade 5, commencing within the range £735 to £860 per annum, ultimately rising to £920 per annum.

Applicants should have a thorough experience in the design, setting out and supervision of site works, including foundations, buildings, and in particular reinforced concrete structures. Considerable experience is necessary in the use of the level and the theodolite, and applicants should be accustomed to dealing with specifications, bills of quantities, drawings, correspondence and should be familiar with site procedure. The successful applicant will be required to act as Assistant to the Authority's Site Engineer. Appropriate technical qualifications will be an advantage.

Apply, quoting the vacancy number 310 MD on Form AE.6, available from the ESTABLISHMENTS OFFICER, 53, WAKE GREEN ROAD, MOSELEY, BIRMINGHAM, 13, by 19th May, 1956. L 460

STAFFORDSHIRE EDUCATION COMMITTEE.

TAMWORTH COLLEGE OF FURTHER EDUCATION.

Required, to take up duties next September, **TWO TEACHERS OF WORKSHOP PRACTICE AND TECHNOLOGY,** and/or Mathematics and Technical Drawing, to level of Ordinary G.C.E., S.1., O.N.C., S.2. Craft for full-time and day-release students.

Salary will be in accordance with the Burnham Technical Scale for Assistants, Grade A, viz., £450 by £18 to £725.

Further particulars and form of application, returnable by 19th May, may be obtained from the undersigned on receipt of a stamped addressed foolscap envelope.

J. H. P. OXSPRING,
DIRECTOR OF EDUCATION.

DEPT. F.E.,
COUNTY EDUCATION OFFICE,
STAFFORD. L 443

CENTRAL ELECTRICITY AUTHORITY.

EASTERN DIVISION.

applications are invited for the following appointment:—

ENGINEERING DRAUGHTSMAN.

LITTLE BARFORD GENERATING STATION.

Salary: N.J.B., Schedule "D," Grade 6, £560 by £20 to £680 per annum.

Applicants should possess a sound general and technical education. Preference will be given to those with experience in Mechanical and/or Electrical equipment associated with a modern Generating Station.

Applications, stating age, details of qualifications and experience, should be sent to the CONTROLLER, CENTRAL ELECTRICITY AUTHORITY, EASTERN DIVISION, NORTHMET HOUSE, SOUTHGATE, N.14, not later than 12th May, 1956.

W. N. C. CLINCH,
CONTROLLER. L 455

THE UNIVERSITY OF SHEFFIELD.

Applications are invited for a post of **LECTURER IN MECHANICAL ENGINEERING,** to begin duties on 1st July, 1956, or as soon as possible thereafter. Salary scale, £650 by £50 to £1350, with F.S.S.U. provision and family allowances. Initial salary according to qualifications and experience.—Further particulars should be obtained from the REGISTRAR, to whom applications (4 copies) should be sent by 9th June, 1956. L 450

ISLE OF WIGHT COUNTY COUNCIL.

ISLE OF WIGHT TECHNICAL COLLEGE.

Applications are invited for the post of **FULL-TIME ASSISTANT TEACHER** in the Engineering Department.

Applicants will be required to teach Workshop Technology and Machine Shop Engineering to first year O.N.C. and intermediate grade craft students, together with the associated science and calculations. Candidates should hold a Higher National Certificate in Mechanical or Production Engineering or a Final City and Guilds Certificate in Machine Shop Engineering. They should have had industrial experience and be capable of handling a small modern machine shop. Drawing office experience is also desirable.

Full particulars and forms of application (stamped addressed envelope) may be obtained from the PRINCIPAL OF THE ISLE OF WIGHT TECHNICAL COLLEGE, HUNNYHILL, NEWPORT, ISLE OF WIGHT, to whom applications should be returned within two weeks of the appearance of this advertisement.

A. L. HUTCHINSON,
COUNTY EDUCATION OFFICER. L 452

STAFFORDSHIRE EDUCATION COMMITTEE.

LEEK COLLEGE OF FURTHER EDUCATION.

Applications are invited for the following full-time teaching appointment to commence not later than 1st September, 1956.

ASSISTANT, GRADE B, to teach Engineering subjects, mainly Workshop Practice and Technology, Technical Drawing with some Science and/or Mathematics. The work will be with full-time and day-release students.

Salary will be in accordance with the Burnham Technical Scale for Assistants, Grade B, viz.: £525 by £25 to £820.

Further particulars and form of application, returnable by 19th May, may be obtained from the undersigned on receipt of a stamped addressed foolscap envelope.

J. H. P. OXSPRING,
DIRECTOR OF EDUCATION.

DEPT. F.E.,
COUNTY EDUCATION OFFICE,
EARL STREET,
STAFFORD. L 444

ENGINEERING DRAUGHTSMEN required. Age, training, experience, salary required, to MINISTRY OF WORKS (ESTAB.), BROOKLANDS AVENUE, CAMBRIDGE. L 424

OXFORDSHIRE EDUCATION COMMITTEE.

NORTH OXFORDSHIRE TECHNICAL COLLEGE AND SCHOOL OF ART, BANBURY.

Principal : N. A. PRATT, A.T.D.

Applications invited for post of **ASSISTANT LECTURER GRADE "A"** to teach electrical installation work up to Final City and Guilds course "B" and to assist with electrical science and mathematics in the national certificate course. Duties will include responsibility for the electrical laboratory. Industrial and teaching experience or training is desirable.

Application forms obtainable from the undersigned should be returned within ten days to the PRINCIPAL, NORTH OXON. TECHNICAL COLLEGE AND SCHOOL OF ART, 51, THE GREEN, BANBURY.

A. R. CHORLTON, M.A.,
DIRECTOR OF EDUCATION,
COUNTY OFFICES,
OXFORD. L 429

E. & F. N. SPON LTD.

The Automatic Factory: What does it mean?

The Report of the Margate Conference of the Institution of Production Engineers, issued on behalf of the Institution.

"This excellent report is one which everyone associated with industry should read and it also contains much of interest and importance to the general public."
AIRCRAFT ENGINEERING.
(105 plates, 65 diagrams, 30/- net.)

Constructional Steelwork

by Oscar Faber

"This very readable book gives a clear explanation of the principles and practice underlying the design of structural steelwork."
ENGINEER.
(139 figures, 32 tables, 50/- net.)

The Design of Cylindrical Shell Roofs

by J. E. Gibson and D. W. Cooper

"A long felt need for a clearly written work setting out the basic principles of design supported by examples of practical application is filled by this book."
THE TIMES REVIEW OF INDUSTRY.
(70 figures, 8 plates, 35/- net.)

22, Henrietta Street W.C.2

NORTH LINDSEY TECHNICAL COLLEGE.
KINGSWAY, SCUNTHORPE, LINCS.

Principal: F. C. JONES, B.Sc. (Eng.), A.M.I.Mech.E., A.M.I.E.E.

Required to commence duties in September, 1956, **ASSISTANT GRADE A** to teach Mathematics, Science and Drawing in Ordinary National Certificate and Craft Courses. Applicants should possess at least a Higher National Certificate in Mechanical Engineering and must have had suitable industrial experience.

Application forms and further details may be obtained from the PRINCIPAL at the above address to whom completed applications should be returned by the 21st May, 1956. L 433

ROYAL AIRCRAFT ESTABLISHMENT
TECHNICAL COLLEGE,
FARNBOROUGH, HANTS.

Applications are invited for the following vacancies in the above selective day College.

1. **SENIOR LECTURER IN PRODUCTION ENGINEERING.**
2. **SENIOR LECTURER IN APPLIED THERMODYNAMICS.**

Candidates should hold a good University degree in engineering, or equivalent, and have had considerable teaching and/or industrial experience.

Successful candidates will be required to teach and organise their subjects throughout the Higher National Certificate, Professional and Degree courses.

The salary is in accordance with the Burnham Scale for Teachers in Technical Colleges which, at present, is £1065 by £25 to £1215, and is subject to the Teachers' Superannuation Acts. Commencing salary in accordance with experience. This salary is being reviewed by the Burnham Committee and it is hoped that it will be increased.

Details and application forms from PRINCIPAL, to whom completed forms must be returned within fourteen days of this announcement. L 427

WOLVERHAMPTON AND STAFFORDSHIRE
TECHNICAL COLLEGE.

Principal: C. L. OLD, B.Sc. (Eng.), M.Sc.Tech.

APPLICATIONS invited for the following posts for September, 1956.

DEPARTMENT OF PRODUCTION ENGINEERING AND MANAGEMENT.

LECTURER for technical management subjects in B.I.M. and Sandwich courses. Candidates must hold a degree or equivalent qualification with appropriate industrial experience.

LECTURER in Mathematics and Mechanics for National Certificate courses. Ability to teach other H.N.C. subjects an advantage. Candidates must hold a degree or equivalent qualification with appropriate experience.

GRADE B ASSISTANT for Metal Working. Processes in C. & G. and National Certificate courses. Appropriate industrial experience. Full Technological Certificate in Machine Shop Engineering and/or H.N.C. essential.

DEPARTMENT OF MECHANICAL ENGINEERING.

LECTURER for Sandwich course and B.Sc. (Eng.) degree level of work.

GRADE B ASSISTANT for Mechanical Engineering subjects.

Appropriate industrial experience and academic qualifications to degree or equivalent level essential.

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING.

LECTURER for Civil and Municipal Engineering. Candidates should have a degree in Civil Engineering and preferably have passed the Testamur examination of the Institution of Municipal Engineers.

In all suitable cases successful candidates will be encouraged to undertake research.

Salaries in accordance with Burnham Technical Report (at present) as follows :—

Lecturer : £965 to £1065.

Grade B : £525 to £820—with additions for training and experience.

Further particulars and forms of application from undersigned (s.a.e.).

G. W. R. LINES,
CLERK TO THE JOINT EDUCATION COMMITTEE.
EDUCATION OFFICES,
NORTH STREET,
WOLVERHAMPTON. L425

CENTRAL ELECTRICITY AUTHORITY,
RESEARCH LABORATORIES, LEATHERHEAD,
require

ENGINEERS in the Generation Section. Investigations cover a wide range or problems on generating plant, including electrostatic precipitation, cooling towers, boiler feed pumps, etc. Experience desirable but not essential. Ability to apply fundamental knowledge to a wide range of problems important.

Candidates for **SECOND/THIRD ASSISTANT ENGINEER** vacancies should preferably have Honours Degree with previous research experience. For others a Pass Degree or H.N.C. is acceptable.

Salaries in N.J.B. Grades :

SECOND ASSISTANT ENGINEER: £995 by £50 to £1345 p.a.

THIRD ASSISTANT ENGINEER: £930 by £30 to £1140 p.a.

FOURTH ASSISTANT ENGINEER: £735 by £25 to £910 p.a.

GENERAL ASSISTANT ENGINEERS: £520 by £25 to £695 p.a. according to qualifications and experience.

Applications, stating age, qualifications, experience present position and salary, to D. MOFFAT, DIRECTOR OF ESTABLISHMENTS, WINSLEY STREET, LONDON, W.1, by 15th May. Quote ref. ENG/805. L 384

NEW SOUTH WALES,
AUSTRALIA.

Permanent appointments in the New South Wales Government Service are available to

ENGINEERS (CIVIL, MECHANICAL OR ELECTRICAL).

SALARY: Commencing salary according to qualifications and experience, between £A1001 per annum and £A1455, with promotion to considerably higher salaries. Superannuation.

QUALIFICATIONS: University Degree, Technical College Diploma, or equivalent.

LOCATION: Sydney or country district offices in New South Wales.

FARES TO SYDNEY: Appointee's contribution to fare is £10 sterling per adult.

Application form and further information may be obtained from the NEW SOUTH WALES GOVERNMENT OFFICES, 56/57 STRAND, LONDON, W.C.2. L 385

APPOINTMENTS OPEN.

THE ENGAGEMENT OF PERSONS answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order 1952.

It is advisable when sending testimonials to forward copies and NOT originals.

THE BRISTOL AEROPLANE COMPANY LTD.,

APPRENTICES' SCHOOL.

Applications are invited for several new posts **(ASSISTANT LECTURER GRADE "A" AND "B")** to teach one or more of the following subjects: Aeronautics, Engineering Science, Mathematics and Electricity. The appointments will date from 1st September, 1956.

The Bristol Aeroplane Company Limited, is the largest single manufacturing unit in the British aircraft industry, and has for many years operated its own Apprentices' School, which is recognized by the Ministry of Education as an Establishment for Further Education. A new School of modern design has recently been opened, in which sandwich and day release courses of Ordinary National Certificate standard in Mechanical and Aeronautical Engineering are offered, together with City and Guilds courses (Intermediate and Final) in appropriate subjects. The School caters for over 1,000 carefully selected apprentices.

Conditions for the teaching staff are most favourable from all points of view, and unequalled opportunities exist for keeping abreast of the latest developments in current aeronautical engineering practice, both in the field of airframes and aero-engines.

Candidates should possess a University Degree or a Higher National Certificate. Letters of application, giving particulars of education, qualifications, industrial experience and any other relevant information, should be sent as soon as possible to:—

THE CHIEF TRAINING OFFICER,
THE BRISTOL AEROPLANE COMPANY, LIMITED,
FILTON HOUSE,
BRISTOL. L 364

ATOMIC ENERGY.

BRUSH ELECTRICAL ENGINEERING LTD., Loughborough, have a vacancy in the Research Division for a

YOUNG MECHANICAL GRADUATE ENGINEER with a good general background who wishes to work on equipment connected with this new and rapidly expanding field. The work is novel and interesting and will shortly be accommodated in new laboratories. The successful candidate will be encouraged to accept responsibility at an early date and will be given every opportunity for advancement. A good salary commensurate with qualifications and experience will be paid and there is in operation a non-contributory superannuation scheme.—Please reply to the CHIEF RESEARCH ENGINEERING. L 449

BRUSH ELECTRICAL ENGINEERING COMPANY LTD., are expanding their range of Switchgear and require a

SENIOR DEVELOPMENT ENGINEER to work on the development of new prototype designs and research into related fundamental problems. Candidates should be capable of bringing an imaginative and original approach to development problems of both a mechanical and electrical nature. Minimum educational standards are a degree or exemption from A.M.I.Mech.E. or A.M.I.E.E. and previous experience in Switchgear is essential. An attractive commencing salary will be paid and there are excellent opportunities. Service conditions include staff bonus and non-contributory superannuation scheme. Applications, giving full details of experience, etc., to the CHIEF PERSONNEL OFFICER, BRUSH ELECTRICAL ENGINEERING CO., LTD., LOUGHBOROUGH, LEICS. L 453

UNILEVER LTD. invite applications for the post of **COMPANY SERVICES ENGINEER** for a rapidly expanding food company. Applicants preferably between the ages of 30 and 40 years, must possess either an Engineering degree or be A.M.I.Mech.E. or A.M.Inst.R. They must have had extensive experience of refrigeration, compressors, boilers, steam distribution, etc. They should be good administrators and capable of co-ordinating work of Factory Engineers, controlling staff and advising the Company on all matters relating to Services. They must be prepared to pay frequent visits to the factories of the Company throughout the U.K. The position is pensionable with excellent conditions of employment. Written applications, giving full particulars of qualifications, training and experience should be addressed to PERSONNEL DIVISION (WAD 116), UNILEVER LTD., UNILEVER HOUSE, BLACKFRIARS, LONDON, E.C.4. L 454

The Plessey Company Limited invite applications from Engineering Estimators with experience of small to medium batch production of :

(A) ELECTRONIC EQUIPMENT
Experience of Post Office and B.B.C. work an advantage.

(B) PRECISION MECHANICAL PRODUCTS
Experience to cover aircraft accessories or hydraulics.

Applicants should preferably have served a good Engineering Apprenticeship and have had at least five years' experience of this class of work. Salary commensurate with qualifications and experience. The positions are permanent and offer excellent prospects of advancement. Applications will be treated in strict confidence, and should be addressed to the PLESSEY COMPANY LIMITED, VICARAGE LANE, ILFORD, ESSEX. L 366

PERSONAL ASSISTANT required by General Manager of a large and well-known firm of Roofing Contractors. Applications are invited from men aged 30 to 40, possessing A.M.I.C.E., A.M.I.Struct.E., or similar qualifications, or failing this having wide practical and executive experience in the building trade. Energy, tact, and the ability to handle correspondence, on a considerable scale, are other important requirements. The post is situated in London, but occasional travel to any part of the British Isles may be necessary. It is pensionable, and offers excellent long-term prospects for the right man.

Applications, giving full details of education and experience to date, and salary required, should be addressed in strict confidence to BOX L 445, Offices of ENGINEERING.

METALLURGISTS.

IMPERIAL CHEMICAL INDUSTRIES, LIMITED, General Chemicals Division, has vacancies for

GRADUATE METALLURGISTS to work on a variety of interesting problems offering scope for application of a wide range of metallurgical principles. The work will be concerned with selection, development, fabrication, corrosion protection and application of materials of construction in large chemical plants. Facilities are available for development work both in the laboratory and on the plants and for the implementation of the results in collaboration with the Engineering Design Department. Excellent prospects exist for men of the right type and, as it is intended to make some of these appointments later in the year, they will be of particular interest to Graduates who are at present nearing the completion of their National Service. Successful candidates will be appointed to the permanent staff of the Company with membership of the Pension Fund and there is also a Profit Sharing Scheme. Where necessary, assistance can be given to married men in connection with house purchase and removal expenses.—Apply, giving full particulars, to STAFF MANAGER, IMPERIAL CHEMICAL INDUSTRIES, LIMITED, GENERAL CHEMICALS DIVISION, CUNARD BUILDING, LIVERPOOL, 3. L 434

THE BRITISH COUNCIL has a vacancy for an **ENGINEER** in the Science Department, London Headquarters. Candidates must be men, preferably between 30 and 40. Corporate membership of I.C.E., I.Mech.E. or I.E.E. essential; engineering degree desirable; at least three years' practical experience in engineering research or development or education or administration required.

Grade 880. Present inclusive salary range £1135 by £35 to £1310 a year. Contributory pension scheme.

Write, quoting F2 (56), to DIRECTOR, PERSONNEL DEPARTMENT, THE BRITISH COUNCIL, 65, DAVIES STREET, LONDON, W.1, for an application form which should be returned completed by 25th May, 1956. L 457

PRODUCTION/PETROLEUM ENGINEER required by Major Oil Company. Graduate required with varied experience in foreign fields to assist in maintaining petroleum engineering and production records, analysing reports, and preparing programmes for overseas operations. Based U.K. with visits abroad. Non-contributory Pension Scheme. Luncheon Club.—Write, giving full details, quoting H.3071, to BOX 8861, c/o 191, GRESHAM HOUSE, OLD BROAD STREET, E.C.2. L 458

DRAUGHTSMEN required for design and detail work on Mechanical Handling Plant for Gas Works, Power Stations, etc. Experience of this type of work comprising conveyors and associated structures etc. desirable but not essential. Good salaries will be paid to suitable applicants with profit sharing bonus and superannuation schemes. Applications in writing giving full particulars of age, experience and salary required to be forwarded to the CHIEF DRAUGHTSMAN, W. J. JENKINS & CO., LTD., 28, VICTORIA STREET, LONDON, S.W.1. L 95

SALES ESTIMATING ENGINEERS.

THE NATIONAL GAS & OIL ENGINE CO., LTD., ASHTON-UNDER-LYNE, have vacancies for **SALES ESTIMATING ENGINEERS** whose duties would include the preparation of tenders for both industrial and marine schemes in the home and export markets of the internal-combustion engine industry.

Previous commercial experience, although an advantage, is not entirely essential providing candidates have an engineering background. The work is interesting and varied and applications should be made in writing to the PERSONNEL OFFICER, THE NATIONAL GAS & OIL ENGINE CO., LTD., RICHMOND STREET, ASHTON-UNDER-LYNE. L 432

ASSISTANT PLANT ENGINEER required with experience of Contractors' Plant and familiar with the requirements of the Factories' Act. Must be competent draughtsman capable of preparing plant layouts for contract works. Works Apprenticeship an advantage. Excellent prospects.—Apply with full particulars of age, education, experience to date and salary required to ROBERT M. DOUGLAS (CONTRACTORS), LTD., 395, GEORGE ROAD ERDINGTON, BIRMINGHAM, 23. L 430

DUNLOP RESEARCH CENTRE offer appointments to

ENGINEERS OR PHYSICISTS, for work on the development, design and manufacturing methods of tyres. These include new types, and tyres having improved mechanical properties. The appointments, calling for initiative and originality, will be made at different levels up to degree in Physics or Engineering. Draughtsmen are also needed in connection with this work. Please write, giving age, experience and salary required, to PERSONNEL MANAGER (J.M.92), DUNLOP RUBBER CO., LTD., FORT DUNLOP, BIRMINGHAM, 24. L 426

DESIGNER DRAUGHTSMAN of Higher National Certificate standard, required for Department engaged on wide range of plant design. Good prospects exist for advancement. Pension Scheme. Canteen and Social Club facilities.—Apply, quoting reference "B," to the PERSONNEL MANAGER, T.I. (GROUP SERVICES) LIMITED, ROCKY LAND, ASTON, BIRMINGHAM, 6. L 398

IMPERIAL CHEMICAL INDUSTRIES LIMITED
METALS DIVISION

Applications are invited for an

ELECTRONICS ENGINEER

to take charge of interesting work connected with the use and development of a new type of instrument for measuring corrosion and erosion in condenser tubes. The successful candidate will be expected to advise and assist customers in the use of these instruments.

Applicants, preferably between the ages of 28 and 35, should have had considerable experience of electronics in the light engineering industry; some knowledge of the non-ferrous tube industry would be an advantage. A sound academic background is desirable, preferably to degree standard.

Excellent conditions of employment include a generous starting salary and adequate scope for progressive remuneration. There is a Pension Fund and a Profit Sharing Scheme in operation and after joining the staff, married men will receive a reasonable refund of removal (including travel) expenses, and to assist them in house purchase, facilities are available, in approved cases, for loans.

Application forms may be obtained from the STAFF MANAGER, I.C.I. METALS DIVISION, KYNOCH WORKS, WITTON, BIRMINGHAM, 6, quoting MPA/1/E. L 374

Classified Advertisements continued on Page 6

GRADUATE ENGINEERS FOR CONSTRUCTION

Applications are invited for the following position with Major Oil Company Middle East.

(1) ENGINEERING ASSISTANT TO CONSTRUCTION SUPERINTENDENT (CIVIL OR MECHANICAL ENGINEER) with over five years experience field engineer construction process plant, industrial and general building projects. Familiar field organisational problems and with good working knowledge general construction and equipment. Age 30-40. Commencing salary £1580 p.a. up according experience, etc.

(2) FIELD ENGINEERS (4) (CIVIL OR MECHANICAL) with over two years experience in either general building projects such as housing, public buildings and utility installations or in oil refinery or chemical process plant installation and utilities. Must be familiar with job planning, scheduling and general construction techniques. Age about 30. Commencing salary £1245 p.a.

In addition to salaries quoted, free air conditioned accommodation and adequate living allowance provided with medical attention, kit allowance, pension plan and paid home and local leaves.—Apply (quoting CON) to BOX G 647, Offices of ENGINEERING.

FERODO LIMITED, manufacturers of friction materials, invite applications for the following positions on the Test House Staff:—

(1) DRAUGHTSMAN-DESIGNER to design new test machines and new devices for the measurement of friction thereon. Candidates must have drawing office experience in design and stress work and should have at least an Ordinary National Certificate, and preferably a Higher National Certificate in mechanical engineering or equivalent. Ref. No. 5033/1.

(2) A TECHNICAL ASSISTANT to carry out investigations on the performance of test machine leading to the improvement of machines, testing procedures and methods of recording; also to organise special tests on proprietary brakes, clutches, overdrives, etc. Candidates should have at least an Ordinary National Certificate in Mechanical Engineering. Ref. No. 5033/2.

(3) A TECHNICAL ASSISTANT to divide his energies, according to varying priority, between the two types of work specified above, i.e., part design and part experimental work. Candidates should have at least an Ordinary National Certificate in Mechanical Engineering. Ref. No. 5033/3.

These are staff positions at attractive salaries and carry a pension. Applications, quoting the appropriate reference number, and giving full personal details including present salary, should be submitted in confidence to the PERSONNEL MANAGER. L 294

WANTED

DRAUGHTSMEN to design in aluminium for sales development. Must possess Higher National Certificate in Mechanical Engineering. Location Banbury. Good working conditions and pleasant surroundings. Attractive starting salaries offered up to £800 p.a. with prospects of promotion from drawing board. Pension plan in operation. Send brief details of qualifications and experience to NORTHERN ALUMINIUM CO., LTD., BUSH HOUSE, ALDWYCH, LONDON, W.C.2. G 562

Leading manufacturers of container closures in the Midlands have a numbes of vacancies for ambitious **DESIGN DRAUGHTSMEN** preferably with some experience in this or a similar sphere. Interesting work with excellent salary and every opportunity for promotion to senior position in a rapidly growing organisation. Write in confidence with details of experience, positions held, salary required, to P.A. METAL CLOSURES LIMITED, BROMFORD LANE, WEST BROMWICH. G 627

DRAUGHTSMEN AND STRESSMEN required for Railway Rolling Stock; knowledge of the industry preferable but not essential; applicants with knowledge of shipbuilding, aircraft, bus or light structural work would be considered.—Apply CHIEF ENGINEER, METROPOLITAN-CAMMELL CARRIAGE & WAGON COMPANY, LIMITED, SALTLEY, BIRMINGHAM. L 104

COPPER DEVELOPMENT ASSOCIATION

GENERAL MANAGER

Applications are invited by the Council of the COPPER DEVELOPMENT ASSOCIATION for the post of GENERAL MANAGER of the Association. The primary objects of the Association are the development of existing and new uses of copper by the preparation and circulation of publications, the arranging of exhibitions, the giving of technical advice to copper consumers and by other activities leading to the correct use of copper.

Experience in responsible post requiring administrative and organising ability is essential and some knowledge of the metals industry is desirable. The commencing salary will be according to qualifications, and not less than £3,000 per annum. The post is pensionable.

Applicants should submit particulars of age, qualifications and experience to the Chairman, Copper Development Association, c/o Selection Trust Building, Mason's Avenue, London, E.C.2, marking the envelope "Personal C.D.A.", not later than the first post May 14th, 1956.

L 404

STRUCTURAL ENGINEER with wide experience of the design and detailing of all types of steel structures and with administrative experience required to act as deputy to the Chief Engineer by large firm of London Consultants. The firm is expanding and the vacancy offers excellent opportunities for the right type of man.—Write in confidence giving details of previous experience and salary required to BOX No. 355, GLOVERS ADVERTISING LTD., 351, OXFORD STREET, LONDON, W.1. G 635

West End London Consulting Engineers require now **SEVERAL SENIOR AND JUNIOR ENGINEER DRAUGHTSMEN** to prepare designs, contract drawings, specifications, etc., for heating, ventilating, boiler plant and allied mechanical services. Interesting work for factories, office blocks, hospitals, colleges, schools, etc. Opportunity for experienced men with initiative. Five-day week. One week's spring holiday in addition to usual summer two weeks. Bonus and optional superannuation scheme.—Write stating age, experience, qualifications and salary required, BOX G 538, Offices of ENGINEERING.

SENIOR CRANE DRAUGHTSMAN required with experience in the design of electric overhead travelling cranes and jib cranes. Pension scheme. House available for successful applicant.—Apply in writing to JOHN SMITH (KEIGHLEY), LTD., P.O. BOX No. 21, KEIGHLEY. L 349

AN ASSISTANT MECHANICAL ENGINEER is required for investigating the many engineering problems encountered in an integrated iron and steel works.

Applicants should be Graduates between 23 and 30 years of age.

Applications to: THE CHIEF ENGINEER, WORKINGTON IRON & STEEL COMPANY, MOSS BAY, WORKINGTON, CUMBERLAND. MARKED PERSONAL. L 352

C.A.V. LIMITED

require an

ASSISTANT DEVELOPMENT ENGINEER

on the design and development of special purpose testing equipment simulating vehicle operating conditions.

Applicants should be up to 30 years of age and must have Higher National Certificate with a sound knowledge of machines and mechanisms; a familiarity with electric or electronic equipment would be an advantage.

Salary according to qualifications and experience.

Five-day week, pensionable, good sports and social facilities.

Write stating age, qualifications and experience to:—

Personnel Manager,
C.A.V. LIMITED,
Warple Way,
Acton, W.3.

L 225

J. MOWLEM & CO., LTD. have vacancies in their Concrete Laboratory for a **CONCRETE ENGINEER** and an **ASSISTANT CONCRETE ENGINEER.** These vacancies are permanent and form an excellent opportunity for the right type of man. Salary according to age and experience. For the junior position previous experience in this type of work is not essential as adequate training will be given.—Apply, giving all details in own handwriting to BOX L 20, Offices of ENGINEERING.

DRAUGHTSMAN, MECHANICAL, required for work on heavy mechanical engineering and pulverised fuel equipment. Experience this class of work would be useful. Voluntary superannuation scheme available working week five days. Please reply, quoting experience. Salary approx. £800.—BOX L 41, Offices of ENGINEERING.

SENIOR ENGINEER required by established firm of Engineering Contractors to be responsible for design of Industrial Finishing Plant such as mechanical painting and drying equipment for the motor and allied industries. Salary £1200 to £1500 p.a. depending on qualifications and experience.—Reply in confidence to BOX L 120, Offices of ENGINEERING.

DRAUGHTSMEN DESIGNERS AND DETAILERS, Senior and Junior required. Experience in Steel Bridges and Structures. Important and interesting work. Permanent positions. High salary. Five-day week. Pension scheme.—Apply stating particulars of experience to THE CLEVELAND BRIDGE AND ENGINEERING CO., LTD., 123, PALL MALL, LONDON, S.W.1. L 180

A FOREMAN, AGE BETWEEN 40/45 YEARS, is required for an old established Ingot Mould Foundry. The applicant should be fully conversant with modern production methods and in the use of sand slingers. The successful applicant would be expected to take full charge of the ingot mould section. All applications will be treated in strict confidence.—Details of age and experience to BOX L 223, Offices of ENGINEERING.

JOHN LAING AND SON LIMITED

invite applications for the following technical staff vacancies :—

STRUCTURAL DESIGN ENGINEERS, preferably qualified, with sufficient design experience to undertake work on their own responsibility.

STRUCTURAL DESIGNER/DETAILERS AND DRAUGHTSMEN with good design office experience.

The appointments are mainly at Head Office, and a wide field of interesting work is covered—particularly suitable for those studying for a qualification. The posts are permanent and pensionable. Five-day week. Staff canteen. Sports Club facilities. Please apply in writing stating age, qualifications and experience to :—PERSONNEL MANAGER (S.D.2), JOHN LAING & SON, LIMITED, BUILDING AND CIVIL ENGINEERING CONTRACTORS, PAGE STREET, LONDON, N.W.7. L 73

ASSISTANT CIVIL ENGINEERS required for immediate posts in Scotland. Positions are long term and carry opportunities where desired for work in London and later abroad. Assurance and staff pensions. Categories required :—

(*a*) Graduates qualifying in 1956, who desire opportunity to complete requirements for Associate Membership of the Institution of Civil Engineers.

(*b*) Associate Membership of the Institution of Civil Engineers or similar standard for either design or site supervision.

BOX G 644, Offices of ENGINEERING.

A.E.C. LIMITED require

DETAIL DRAUGHTSMEN. Experience of the motor industry an advantage. Modern offices and equipment, excellent opportunities for progress. Good salary offered, five-day week, pension scheme and canteen facilities.—Applications in writing, giving age, experience and salary required to STAFF RECORDS OFFICE, WINDMILL LANE, SOUTHALL, MIDDLESEX. K 877

A MECHANICAL ENGINEER is required by the WESTINGHOUSE BRAKE & SIGNAL CO. for work in connection with design, development and testing of mechanical, pneumatic and electro-mechanical equipment for Railway Signalling. Applicants are not expected to have had experience of this particular type of work, but some experience of design of mechanical equipment is desirable. The minimum qualification is H.N.C. in mechanical engineering. Salary will be in accordance with age, qualifications and experience. The Company operates a Pension Scheme, and a 5-day week. Write giving details of age, qualifications and experience, to PERSONNEL SUPERINTENDENT, WESTINGHOUSE BRAKE & SIGNAL CO., LTD., CHIPPENHAM, WILTS, quoting reference No. EQUIP/N/O. L 121

PLANT ENGINEER 25-35 YEARS, required for progressive Company of Engineers and Founders. Group Pension Scheme and Employees Share Holding Scheme operated. Applications in writing to KENT ALLOYS LIMITED, TEMPLE MANOR WORKS, ROCHESTER, KENT. L 124

BRITISH PETROLEUM COMPANY, LIMITED, has immediate vacancies for **CHEMISTS, PHYSICISTS, CHEMICAL ENGINEERS AND MECHANICAL ENGINEERS** for work in their United Kingdom Refineries and at their Research Station at Sunbury-on-Thames. Applications are invited from men with University degrees or equivalent qualifications and who have fulfilled National Service obligations. Previous Industrial experience desirable but not essential. Age preferably not above 33. Salaries within the range £650-£1300 according to qualifications and experience. Excellent working conditions. Non-contributory Pension Scheme.—Write, giving 565 details quoting H.3297 to BOX 8580, c/o full. GRESHAM HOUSE, E.C.2. G 565

DRAUGHTSMEN (SENIOR AND JUNIOR) required for work in connection with the following branches of Coke Oven and Gasworks plants.

(*a*) Mechanical and By-Product Plant.
(*b*) Pipework.
(*c*) Steelwork for Buildings and Conveyors.

Applicants should be competent men able to work with the minimum of supervision. Technical qualifications to O.N.C. or beyond. Good remuneration and prospects for capable men. Pension scheme. Five-day week ; Canteen Facilities.—State age and experience to the PERSONNEL OFFICER (D.O.), WOODALL-DUCKHAM CONSTRUCTION COMPANY LTD., WOODALL-DUCKHAM HOUSE, 63-77, BROMPTON ROAD, LONDON, S.W.3. G 550

BRITISH PETROLEUM COMPANY LIMITED requires

ENGINEERS OR PHYSICISTS with University Degrees, for experimental work on internal combustion engines including gas turbine engines and motor vehicle engines of high performance. Previous practical experience is not essential, but applicants should have a keen interest in this type of work. Age preferably not above 33. Salaries within the range £650 to £1300 per annum, according to qualifications and experience.—Write, giving full details, quoting H.3299, to BOX 8565, c/o 191, GRESHAM HOUSE, E.C.2. G 638

THE RESEARCH DEPARTMENT OF METROPOLITAN-VICKERS ELECTRICAL CO., LTD., TRAFFORD PARK, MANCHESTER, 17, has a further vacancy for an

ENGINEER OF HIGHER NATIONAL CERTIFICATE STANDARD or equivalent for practical research and development, in the laboratory and in the works, of a wide variety of machining processes. Some initial training will be given where necessary.

Write for application form to: PERSONNEL MANAGER, METROPOLITAN-VICKERS ELECTRICAL CO., LTD., TRAFFORD PARK, MANCHESTER, 17. Quote reference J.4. G 641

DRAUGHTSMAN required for Engine Design Schemes on small high-speed diesels must have initiative and experience. Good salary. Pleasant working conditions. Pension Scheme.—Apply CHIEF PERSONNEL OFFICER, PETTERS LIMITED, CAUSEWAY WORKS, STAINES. G 650

DETAIL DRAUGHTSMEN required. Men experienced in Industrial Furnace, Gas Plant or similar work preferred. Write giving full particulars and salary required to CHIEF DRAUGHTSMAN, FURNACE DEPARTMENT, THE WELLMAN SMITH OWEN ENGINEERING CORPORATION LIMITED, PARNELL HOUSE, WILTON ROAD, LONDON, S.W.1. L 125

DESIGN DRAUGHTSMEN.

Design Draughtsmen (mechanical) required by rapidly expanding N.W. London Company with factories in provinces. Capable designers are needed to work on plant development and production operation extensions. Experience of factory layout, services and intricate mechanisms an advantage. Technical qualifications to H.N.C.; O.N.C. considered but dependent on experience. Salary £800 p.a. upwards according to ability. Excellent prospects, pension and life assurance scheme. Five-day week.—Full details in strict confidence to BOX L 238, Offices of ENGINEERING.

MECHANICAL ENGINEER required with first-class experience in diesel and/or gearing work. Sound qualifications essential, including good drawing office experience. 25 miles N.W. London. Superannuable. Commencing salary £800 per annum —Write with full details BOX A.C.18415, SAMSON CLARKS, 57-61, MORTIMER STREET, W.1. L 265

JUNIOR DRAUGHTSMEN required, O.N.C. standard, experience in general engineering and/or sheet metal fabrications for work on specialised equipment for the Dairy, Brewery and Chemical Industries. Salary commensurate with experience.—BOX L 284, Offices of ENGINEERING.

TO COPE WITH RAPIDLY EXPANDING HOME AND EXPORT DRIVE,

CROFTS (ENGINEERS) LIMITED, THORNBURY, BRADFORD, YORKS.

URGENTLY REQUIRE

DRAUGHTSMEN

Salary, bonus and prospects are excellent for men with necessary experience and qualifications.

Applicants should have good general Engineering experience. Knowledge of Gear Units, Clutches and Transmission Equipment an advantage. Educated preferably to Higher National standard.

The positions are permanent and superannuated.

Applications to be made in writing to PERSONNEL MANAGER and endorsed D.O.3.

Travelling expenses for interviews will be refunded and all matters relating to the applications will be regarded as strictly confidential. L 270

Classified Advertisements continued on Page 8

★ **PROGRESS IN ELECTRONICS**

This scientist is using high vacuum techniques to study the purity of valve components.

thought for tomorrow

Sometime in the future the results of this man's research will be applied to the solution of a production problem. The outcome may be a better quality product, or a cheaper product, or a better method of analysis or control.

You yourself may benefit from his work, for the chances are that in your industry, too, electronics has an increasingly important part to play.

Mullard scientists work hand in hand with the designers of Britain's leading electronic equipment manufacturers, and this combination helps to produce the finest equipment in the world. You can invest in it with confidence, for nowhere else will you find greater efficiency and reliability.

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ELECTRONIC VALVES AND TUBES · SEMI-CONDUCTOR DEVICES · MAGNETIC COMPONENTS · SPECIALISED ELECTRONIC APPARATUS · FINE WIRE

MULLARD LTD., CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2

MPS24E

BRITISH CELLOPHANE LIMITED,
BRIDGWATER, SOMERSET,

seeks **SENIOR AND JUNIOR DRAUGHTSMEN,** for both PERMANENT and TEMPORARY appointments, for work on machine design and chemical plant layout. Applicants should possess at least O.N.C. and have had three years' shop experience. Five-day week, Pensions Fund scheme for permanent appointments. Ref. No. E.48.Eg.

The TEMPORARY appointments are for a period of approximately two years' duration, subject to three months' notice and include generous subsistence allowances, and periodic home return rail fares.

ESTIMATOR (PERMANENT).—Applicants should have served an engineering apprenticeship and have technical education up to O.N.C. standard. The work involved will be on the preparation of material and labour specifications in connection with engineering work, electrical estimating experience an advantage. Ref. No. E.49.Eg.

ASSISTANT ENGINEER, age 23/30 (permanent).—Applicants should have an honours degree in mechanical engineering and have had some practical works experience. The duties will be on development, improvement and maintenance of chemical and other plant. Ref. No. E.50.Eg.

ASSISTANT ENGINEER, age 25/50 (permanent).—Applicants should have a university degree and have works experience, or be an A.M.I.Mech.E. The duties will be on development, improvement and maintenance of plastic films extrusion plant and ancillary equipment. Ref. No. R.45.Eg.

Write to the PERSONNEL OFFICER, stating full particulars and salary required, and quote Ref. Nos. as indicated. L 32

SENIOR DESIGN ENGINEERS

with experience in the chemical engineering or associated fields and who have been concerned with design problems related to heat exchangers, fractionating columns and pressure vessels or with associated equipment e.g., pumps, compressors.

Applicants should hold an engineering or science degree and have the ability and enthusiasm to lead a design team engaged on a variety of projects and ultimately to take up more senior executive appointments.

Applications should be addressed to:
The Personnel Manager,
BRITISH OXYGEN ENGINEERING LTD.,
15, STONE CROSS, THE HIGH,
HARLOW, ESSEX. L 372

DRAUGHTSMAN, with experience in preparation of complete Heating Schemes with ability to develop new ideas. Excellent opening for capable and ambitious heating engineer. Full details age, experience, salary.—BOX L 463, Offices of ENGINEERING.

PRECISION CERAMICS.

An engineering company in the Midlands has created a new department. As a result of this it has **A VACANCY WHICH HAS EXCEPTIONAL OPPORTUNITIES FOR THE RIGHT MAN.** It is hoped that the selected candidate will become head of the department.

The work involves reading and interpreting engineering drawings, making models from them to close tolerances in ceramic materials.

REMUNERATION—Starting remuneration £1500 per annum. A generous pension fund is available.

TRAINING—The selected candidate must be willing to reside for a short period in the U.S.A. to study specialised techniques.

PROSPECTS—The prospects with this company, which has an international reputation, are extremely good.

Write, giving full details, not later than May 25th, to BOX L 465, Offices of ENGINEERING.

BRISTOL AERO-ENGINES LTD.

★

SOMETHING NEW FOR DRAUGHTSMEN

Bristol Aero-Engines Ltd., have vacancies for Designer Draughtsmen anxious to specialise in Blade Design, manufacturing techniques and forward developments. These aspects of Gas Turbine Engineering hold a key position in the development of existing types and the design of new engines. Applicants should have previous Mechanical Drawing experience and preference will be given to those holding the O.N.C. or H.N.C. No previous experience on blade work is required, training being provided during course of the job.

A good salary, with the usual generous Pension and Welfare facilities, will be paid to those who demonstrate their suitability for work in this new field.

★

Letters, quoting 75/JEG, giving a brief outline of qualifications and experience should be addressed to the Personnel Manager, Bristol Aero-Engines Ltd., Filton House, Bristol.

BRISTOL

L 472

ARMSTRONG SIDDELEY (BROCKWORTH) LIMITED invite applications for the following vacancies :—

QUALIFIED METALLURGIST as Assistant to Chief Metallurgist. Applicants should possess a degree in metallurgy or an Associateship of the Institute of Metallurgists, and in addition have had at least three years' industrial experience.

METALLURGICAL ASSISTANT to take control of a creep testing Laboratory. Qualifications to H.N.C. Standard with previous experience of this type of work on high temperature alloys.

ANALYTICAL CHEMIST. A Senior Laboratory Assistant with experience in ferrous and non-ferrous analysis.

Apply either personally or in writing to the PERSONNEL MANAGER, ARMSTRONG SIDDELEY (BROCKWORTH) LTD., HUCCLECOTE, GLOS. L 405

A CHIEF METHODS ENGINEER,

aged 35-45, is required by an old-established medium/heavy engineering company in South Lancashire. The position is of Senior Executive status and calls for a first class technical and practical engineering background. An engineering degree or membership of a suitable professional institution will be an advantage but not a necessity.

Duties include control of jig and tool design, planning, ratefixing, toolroom and tool stores, with a total staff of 80. A comprehensive pension and insurance scheme is in operation.—Applicants should give fullest details of education, previous experience, age and salary required to BOX L 411, Offices of ENGINEERING.

TECHNICAL SALES REPRESENTATIVE

required by a well-known Machine Tool Company for the Lancashire area. Must have a good general knowledge of machine tool production and of production methods. Age 25 to 35, able to drive car to be provided. Progressive position for suitable man.—Send full details of training, past employment, salary required, etc., to BOX L 367, Offices of ENGINEERING.

INSTRUMENTATION

COURTAULDS LIMITED requires a **TECHNICAL ASSISTANT** in the Central Instrument Department in Coventry. Work includes the carrying out of technical calculations, correlation and assessment of data, etc., and assisting in the preparation of instrument control schemes for a wide variety of processes. Experience in the instrument field is not an essential requirement for this position.

Men: Minimum qualification National Certificate in Engineering but Higher National very desirable.

Women: This vacancy would be of interest to a young lady who has Advanced G.C.E. as a minimum qualification with an interest in mathematics and physics.

Candidates should write giving full particulars to the PERSONNEL DEPARTMENT, COURTAULDS LIMITED, 16 ST. MARTINS-LE-GRAND, LONDON, E.C.1, quoting reference number B.34. L 467

BILLINGHAM ICI DIVISION

Vacancies for

MECHANICAL ENGINEERS

This division of I.C.I. Limited offers outstanding opportunities for University Graduates in Mechanical Engineering whose training and experience will enable them to take their place in an expanding industry requiring versatility and technical competence. Individual careers are carefully planned for young engineers to give them a wide technical experience and early responsibility on the management side.

Billingham annually produces over 2,000,000 tons of heavy chemicals, among them being ammonia, fertilisers, sulphuric acid, urea, methanol, petrol, and many organic chemicals derived from petroleum. Each new product presents its own engineering problems which have to be solved before full-scale production can begin. The Division therefore maintains its own Engineering Research Department and has a very extensive design organisation. On the production side process engineering provides an excellent opportunity for the engineer who wishes to combine his technical interests with those of management.

These appointments are permanent and pensionable and carry attractive salaries. There is also a profit-sharing scheme in operation. Assistance can be given towards house purchase and removal expenses in the case of married men.

Write, giving brief details of age, qualifications and experience, to the Staff Manager, Imperial Chemical Industries Limited, Billingham Division, Billingham, Co. Durham, quoting reference A.5. L 261

TECHNICAL REPRESENTATIVE (25-35) required for Vibro Insulator Sales Department in large rubber manufacturing company with their Head Offices in Westminster. Candidates should have sound engineering qualifications and some sales experience. Will be required to assist in development as well as sales and therefore knowledge of vibration, sound and shock absorption products an advantage. Good salary and prospects. Pension scheme.—Applications to GROUP PERSONNEL MANAGER, BRITISH TYRE & RUBBER CO., LTD., HERGA HOUSE, VINCENT SQUARE, LONDON, S.W.1. L 439

INSTRUMENT ENGINEER.

COURTAULDS LIMITED require an Instrument Engineer for their Central Instrument Department in Coventry. Applicants must be familiar with modern instrumentation theory and practice and be experienced in the handling of Instrumentation schemes for the automatic control of chemical processes, from the flow sheet stage to final commissioning.

Qualifications desired are a degree in a branch of engineering or physics, but applicants will be considered who have the required experience and alternative qualifications.

Candidates should write for a detailed form of application to the DIRECTOR OF PERSONNEL, COURTAULDS LIMITED, 16 St. Martins-le-Grand, London, E.C.1, quoting reference number B.35. L 466

C.A.V. LIMITED have a vacancy for a **PHYSICIST, OR ENGINEER** up to H.N.C. standard or equivalent, for fundamental studies and service of filters and wear. Experience of filter work or particle size analysis would be an advantage, but is not essential. 5-day week, pensionable, good sports and social facilities.—Write stating age, qualifications and experience, to THE PERSONNEL MANAGER, C.A.V. LIMITED, WARPLE WAY, ACTON, W.3, quoting Ref. R.21. L 461

JOSEPH BOOTH & BROS., RODLEY, LEEDS, have vacancies for the following personnel in their Drawing Office:

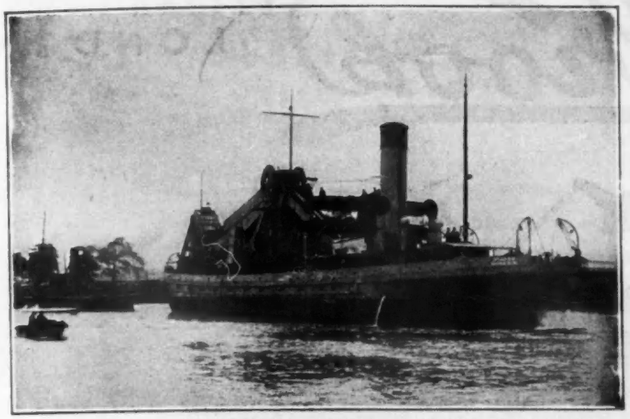
WELDING ENGINEER to check welding design and supervise and develop welding technique generally; Plant Draughtsman with structural building experience.

ELECTRICAL DRAUGHTSMAN for the layout and ordering of crane electrical equipment and preparation of wiring diagrams;

Five-day week; superannuation scheme; canteen; Apply in writing to the CHIEF DRAUGHTSMAN, stating age, experience and salary required. L 468

WANTED, EXPERIENCED ENGINEER for supervising the erection of mechanical, thermal and electrical equipment of a Power Station in Mozambique and also for putting this station into service. Minimum assignment: two years.—Reply with full details and salary required to BOX L 363, Offices of ENGINEERING.

Classified Advertisements continued on Page 130



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constructed for the
OTAGO HARBOUR BOARD, DUNEDIN, NEW ZEALAND.
Dimensions: 258 ft. × 20 ft. Hopper capacity 2,000 tons.
Speed loaded: 9½ knots. Dredging capacity per hour: 1,000 tons.

DREDGING PLANT

TO THE LARGEST DIMENSIONS AND CAPABILITIES

PATENT CUTTER SUCTION DREDGERS, PATENT DIPPER DREDGERS, BUCKET HOPPER DREDGERS, SUCTION HOPPER DREDGERS, HOPPER BARGES, PIPE LINES, FLOATING CRANES, etc.

NEW BUCKETS, LINKS, PINS, GEARING, etc., supplied for existing Dredgers.

FLEMING & FERGUSON, Ltd.,

SHIPBUILDERS & ENGINEERS, PAISLEY, SCOTLAND.
Phone: Paisley 4121. *Teleg. Address: "Phemis, Paisley."*
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MANUFACTURERS OF
HEAVY IRON CASTINGS UP TO 20 TONS
STEEL FABRICATIONS FOR HEAVY ATOMIC PLANT
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builders of locomotives, Diesel and Steam for many parts of the world. . .

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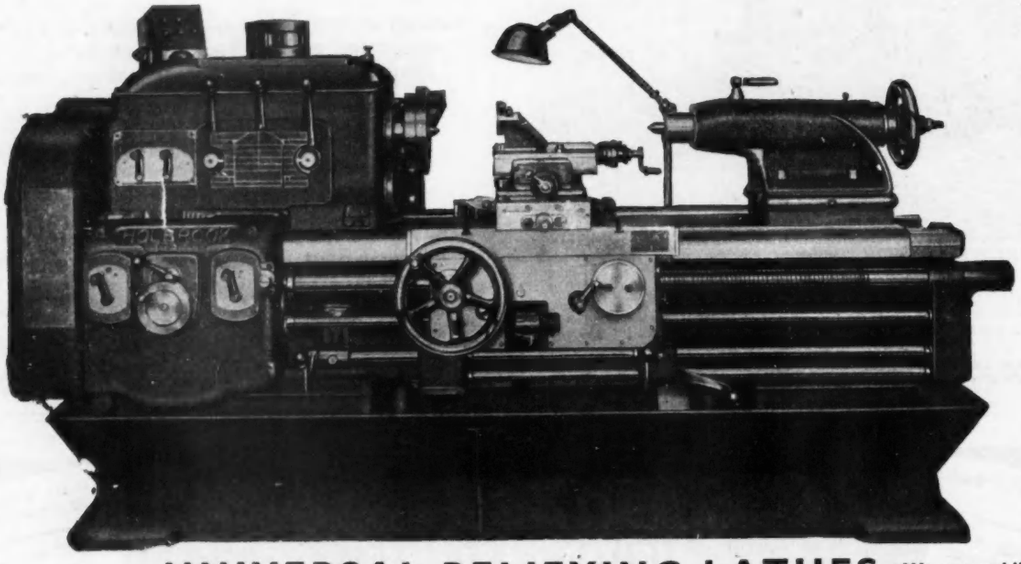
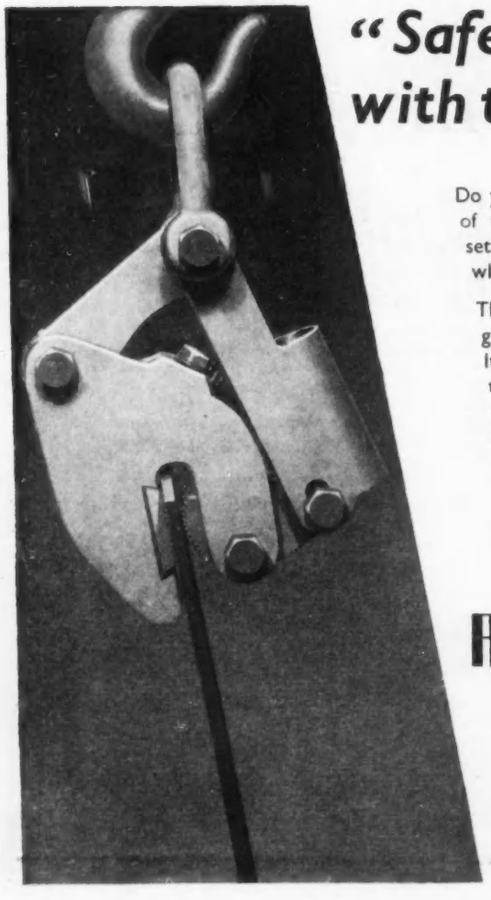
STRATFORD **Holbrook** LONDON



UNIVERSAL RELIEVING LATHES
MODEL "R"
Built in two sizes for cutter diameters 4 and 9 inches

The Finest Lathe in its Class

We are exhibiting at the INTERNATIONAL MACHINE TOOL EXHIBITION, LONDON June 22 - July 6 GRAND HALL STAND No. 29



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Do you experience delay and accidents as a result of faulty plate lifting clamps? These wasteful setbacks are unnecessary and avoidable—even where crane vibration and load bumping occur.

This new Green Vertical Plate Lifting Clamp will grip plates, and hold them, under all conditions. It is available in a range of five sizes for plates up to 2½in. thick and up to 10 tons loading. Why not write for further information today? Patent application No. 12830/53.

If you have a lifting problem in your factory that has thus far defied solution, our Special Service Department would like to assist you. Your enquiry will receive our immediate attention.

RICHARD GREEN LTD

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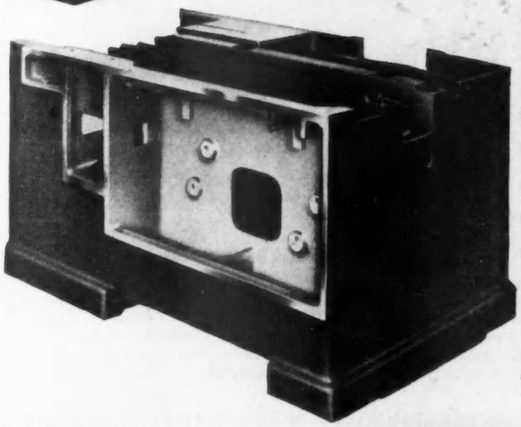
QUALITY CASTINGS

in Grey Iron



We manufacture iron castings by both the mechanised and floor moulded methods. Maximum unit weight: 5 tons.

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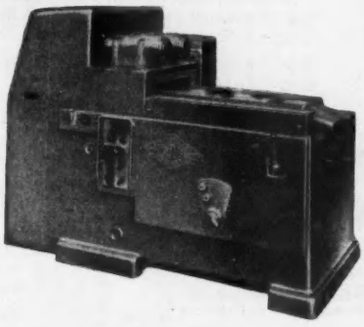

Q & S Grey Iron Castings are used where only the best is good enough. That is why John Lund Ltd. specify them for use in the construction of their *Precimax* Fine Boring Machines. The illustration above shows a body casting for a *Precimax* Single-ended Fine Boring Machine, and the smaller illustration at right shows a completed machine.

If you also require castings of the highest quality you cannot do better than to have them

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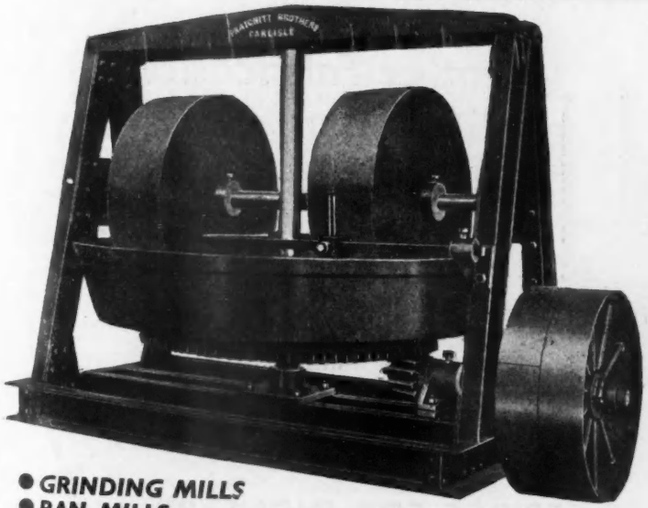

- *GRINDING MILLS*
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- *EDGE RUNNER MILLS*

for grinding and mixing Mortar Sand, Ores, Minerals, etc.

Enquiries also invited for:

Elevators and Storage Hoppers, Impregnating Plants, Calciners, Rotary Dryers, Mixers and Blenders, Gypsum Plant, Castings up to 5 tons in weight, General Engineering Plant. Equipment manufactured to customers' drawings and specification.

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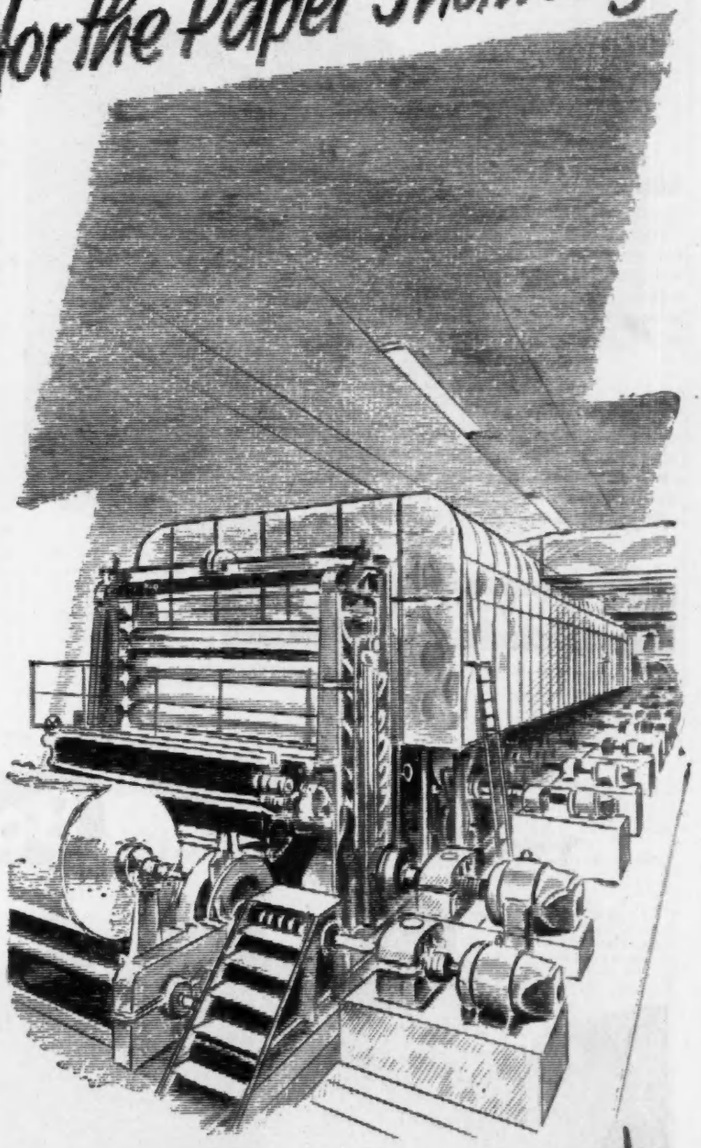

AEG *means* **ELECTRICITY**

Only well designed electric drives coupled with accurate regulation enable the paper industry to cope with ever increasing demands.

Extensive work by the AEG in this field helped to increase production and economy with added safety.

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Let **SPARKLETS**
engineers get
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DIE-CASTING DESIGNS
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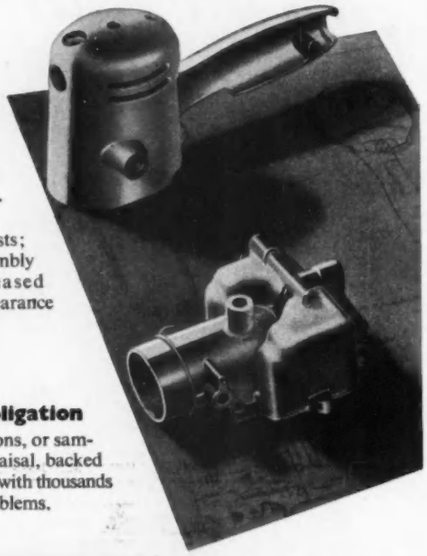

REMEMBER
Sparklets Pressure Die-Casting will:
cut your piece price costs;
reduce machining and assembly operations with increased strength and improved appearance of the casting.

For quotation without obligation
send blueprints, specifications, or sample castings for expert appraisal, backed by over 40 years' experience with thousands of **PRESSURE DIE-CASTING** problems.

SPARKLETS PRESSURE DIE-CASTINGS

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Tinsley STRAIN GAUGES

The use of electrical wire resistance strain gauges has now been accepted by engineers as one of the most important means of investigating stresses and strains in all types of structures and machines. The electrical resistance strain gauge consists of a grid of fine wire bonded to a paper or Araldite membrane which can be cemented to the surface under investigation. Connections are taken from the gauge to apparatus designed to give reliable and quick readings of the strain being measured.

The above gauges are available in various designs to meet individual requirements, and a wide range of measuring instruments can be supplied for indicating or recording static strains.

Write for lists 210 and 210A, which give full particulars of all the above gauges and associated apparatus.

Gauges are available in the following types :

(*a*) *Durofix bonded, paper backed, resistance* 50 Ω *to* 2,000 Ω, *maximum temperature* 60° *C. Wire wound.*

(*b*) *Araldite bonded, wire wound on Araldite backing. Maximum temperature* 80° *C. Resistance* 50 Ω *and* 100 Ω.

(*c*) *Bakelite bonded, wire wound. High temperature* 200° *C. Resistance* 250 Ω.

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H. Tinsley & Co. Ltd.
Werndee Hall,
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Another Fabrication by Gimson

This 16-ton fabrication, intended for sugar processing, is a typical example —but by no means the largest— of the type of work we are particularly well equipped to handle. We can cope with most types of steel plate work, for which we have the experience, capacity and specialised resources. Technical Representatives will call on request.

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A COMPLETE SERVICE FOR INDUSTRY

Iron Castings up to 10 tons. Steel fabrications of all shapes and sizes. Steel plate in stock up to 4 ins. thick. Special purpose machinery and perforated plate work for screens of all sizes.

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GASKETS AND OIL SEALS
AUTO-MOTIVE MOUNTINGS
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in
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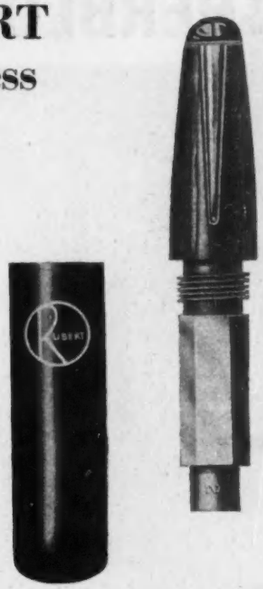
HOPE MILL · PORTWOOD PLACE · STOCKPORT

TELEPHONE : STO. 2617/8.

Introducing :

The New RUBERT Surface Roughness Pencil



which is made to be carried in the pocket in the same manner as a pencil.

The scales are made from specially selected square stainless steel and each face is ¾in. long by ¼in. wide.

There are two models, viz.:—

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Model 42/S indicating 4-8-16-32-63-125-250-500-1000 Micro" C.L.A. to BS. 1134: 1950.

Prices are as follows:—

Model 40/S	£4.19.0
Model 42/S	£8.16.0

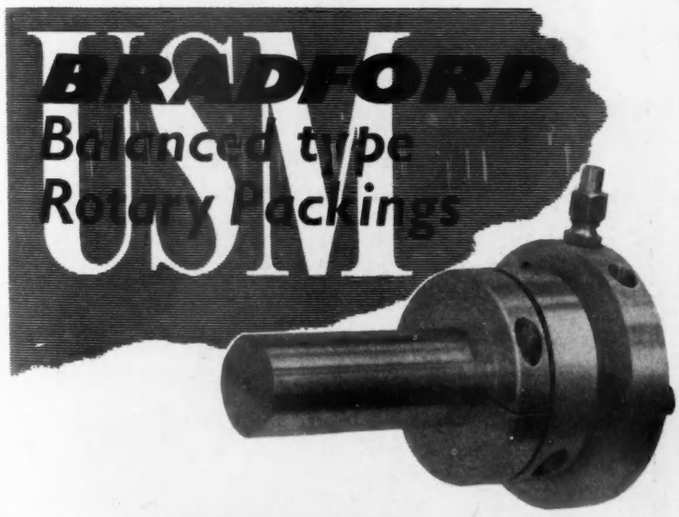
The new Models also contain surface Finish Colour Code.

EVERY ENGINEER WHO HAS THE *NEW* RUBERT SURFACE ROUGHNESS PENCIL in his pocket becomes Surface Finish conscious, and soon this is reflected in the quality of his work.

Also makers of :—
SURFACE PLATES and TABLES · STRAIGHT EDGES
LAPPING PLATES · FEELER GAUGES
PRECISION GAUGES, etc., etc. ★ *Ask for leaflets*

RUBERT & CO. LTD., CHAPEL STREET, LEVENSHULME, MANCHESTER, 19

Telephone : RUSHOLME 4613



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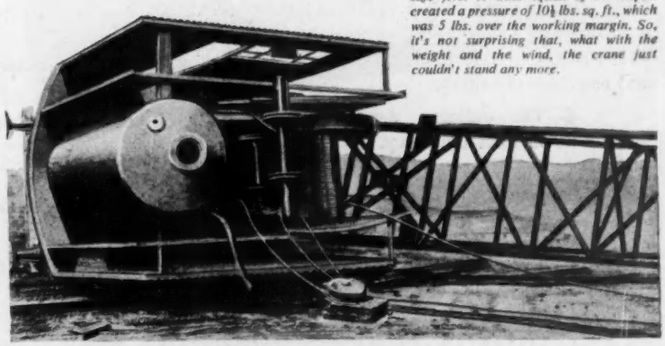

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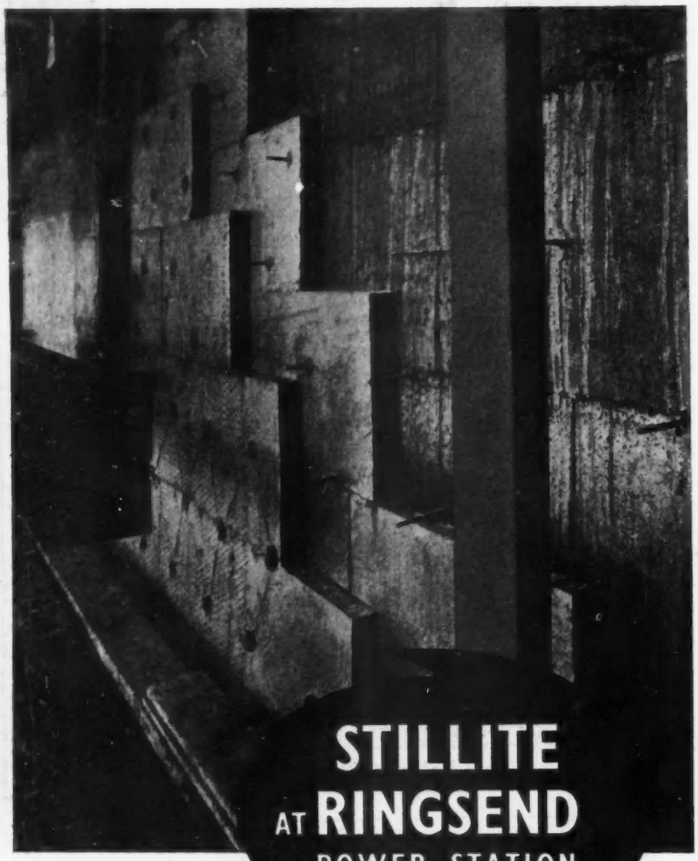

STILLITE AT RINGSEND POWER STATION

Photograph by kind permission of the Electricity Supply Board, Dublin, and Messrs. Babcock and Wilcox Ltd.

THERBLOC mineral fibre insulating slab is rapidly replacing conventional backings to refractory materials in a wide variety of industries. The photograph shows STILLITE THERBLOC applied in two staggered layers to the outer surface of the castable refractory and held by pins secured to the tubes.

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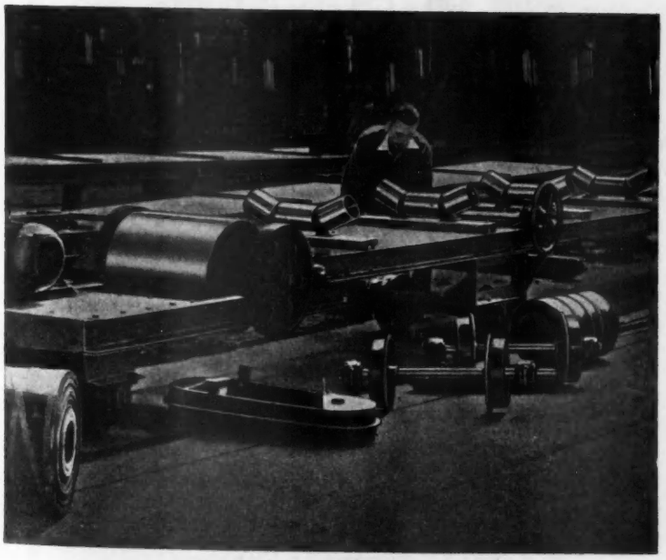

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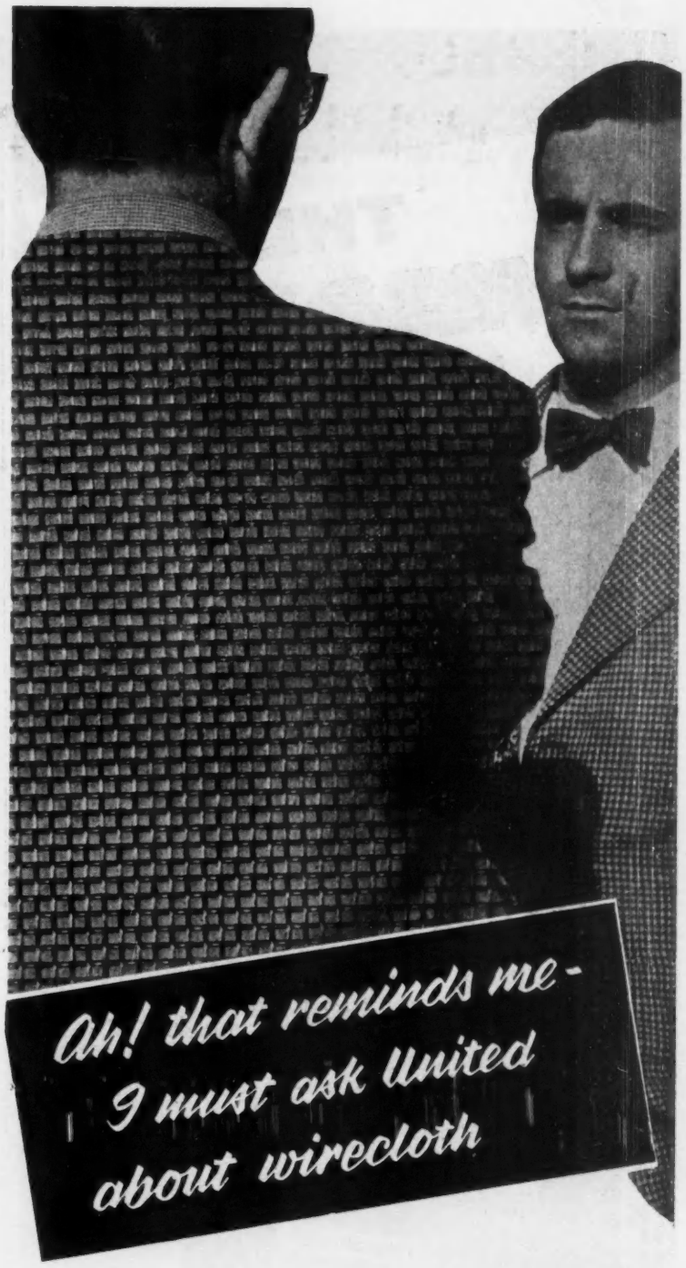

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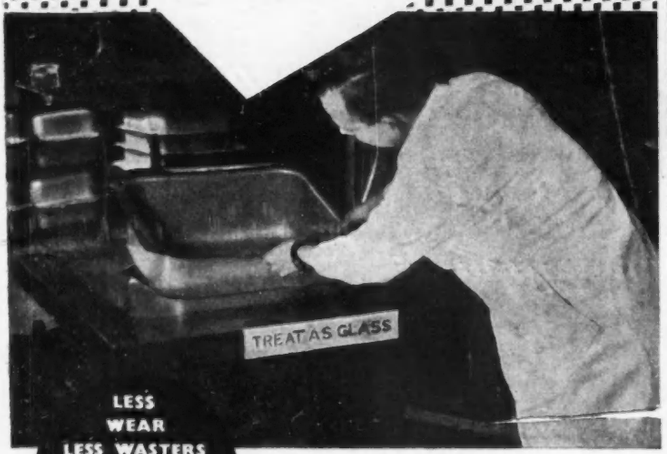

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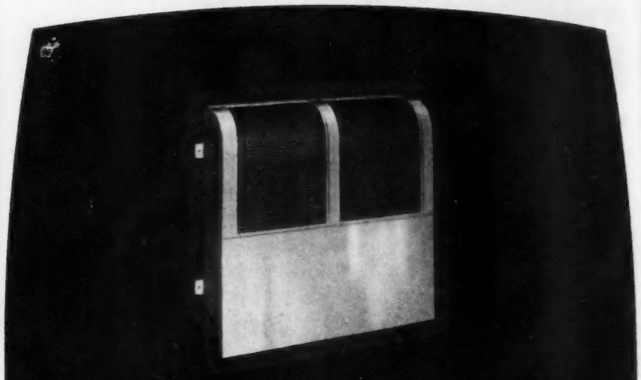

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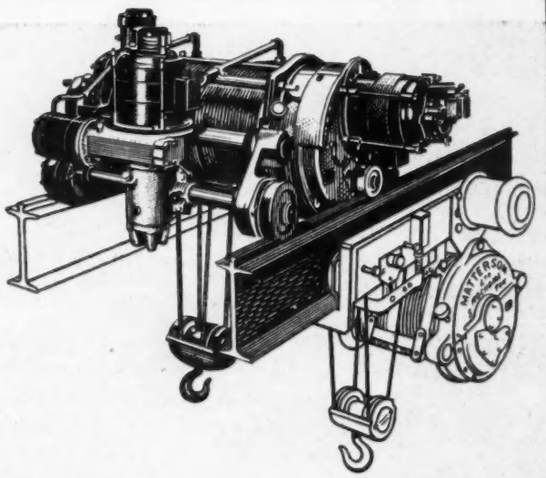

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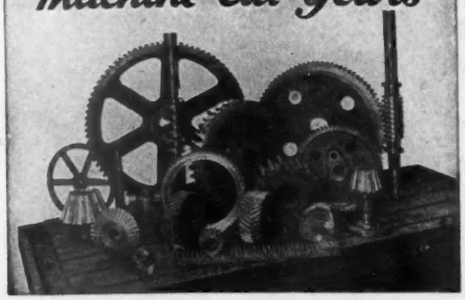

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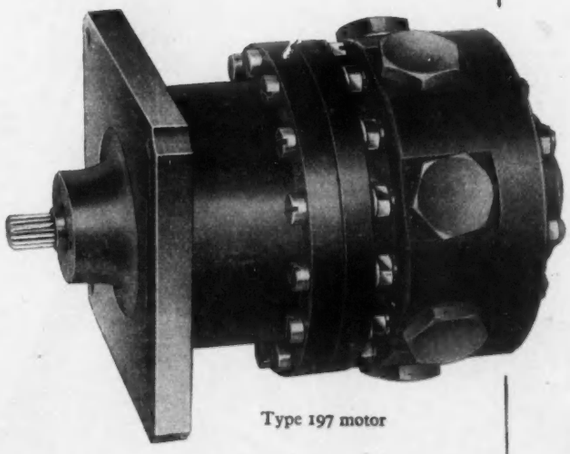

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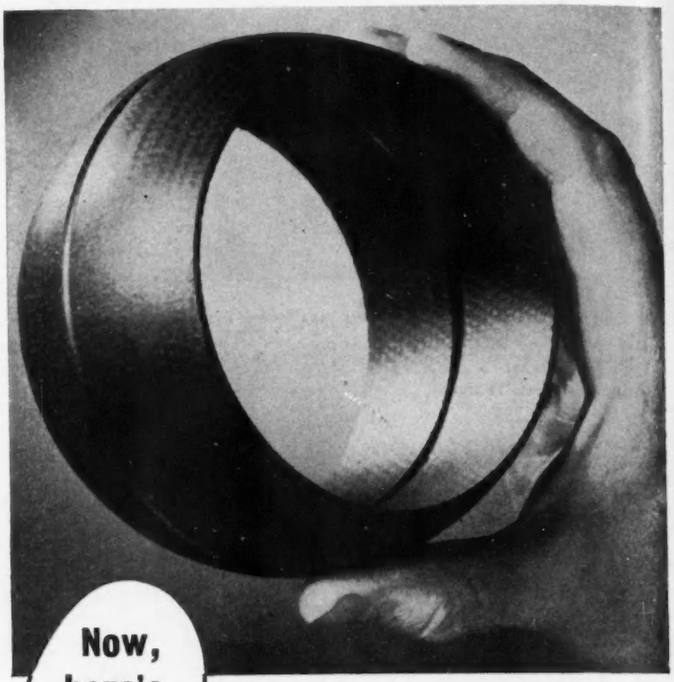

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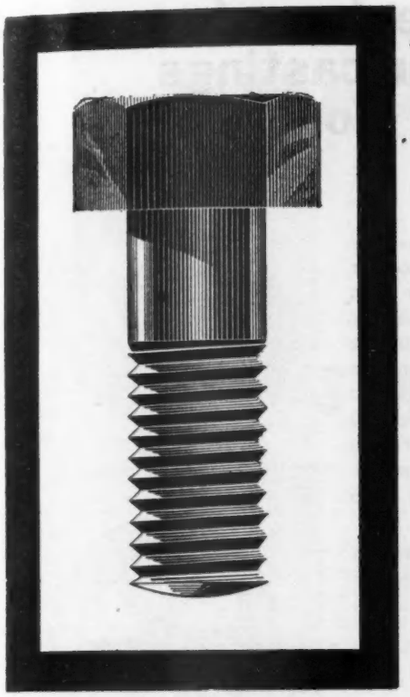

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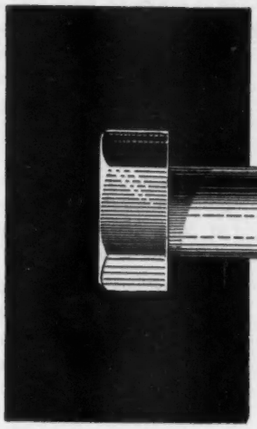

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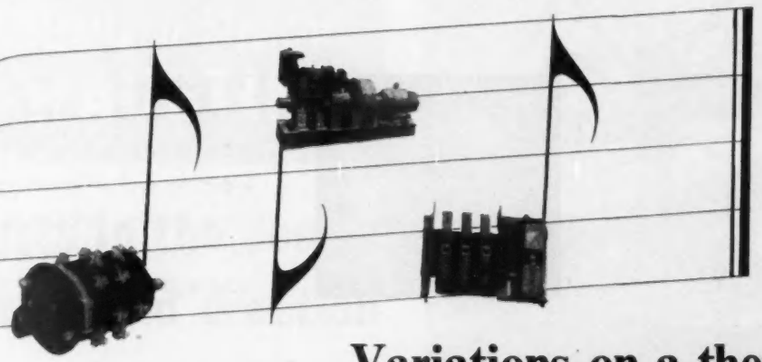

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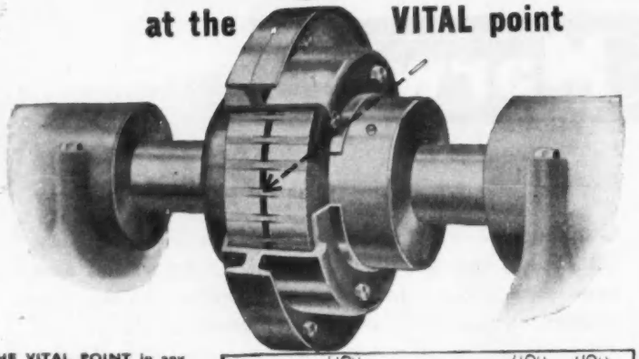

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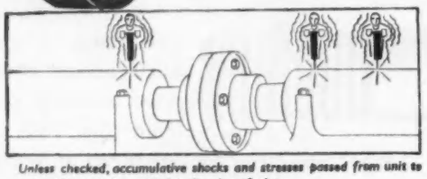
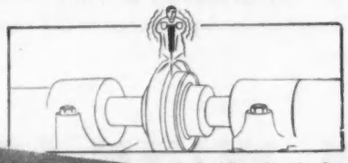


Unless checked, accumulative shocks and stresses passed from unit to unit will result in rapid deterioration of plant.



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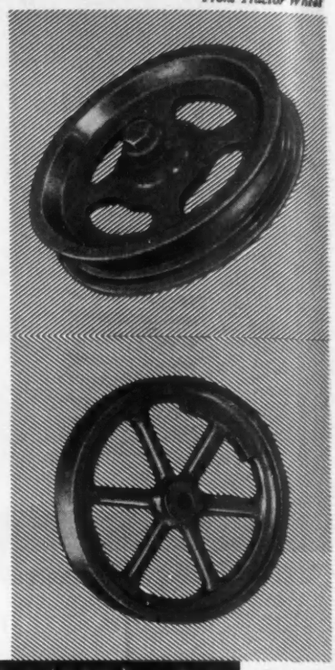

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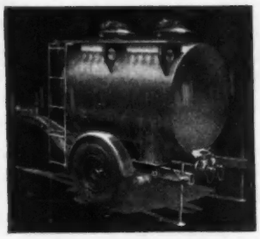

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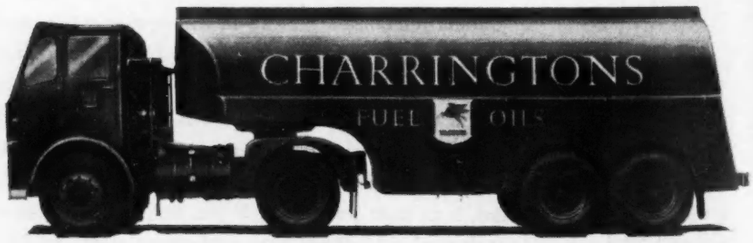

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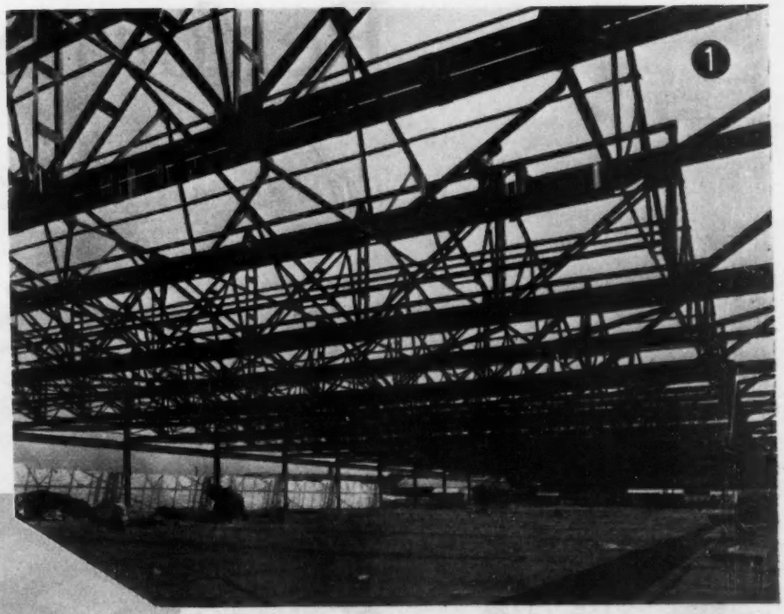

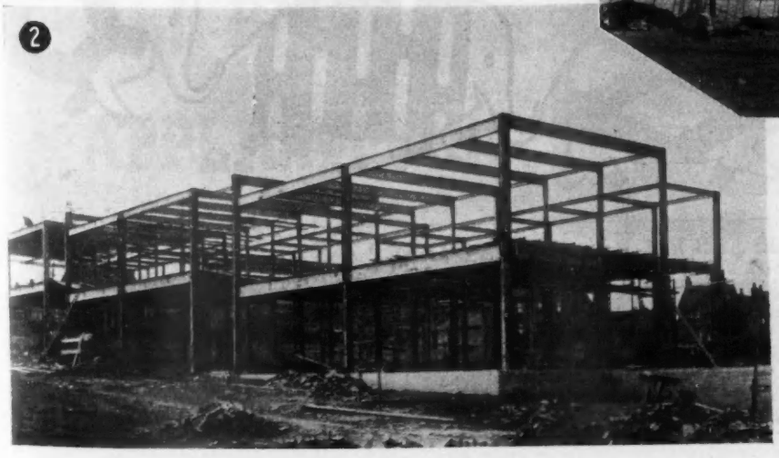

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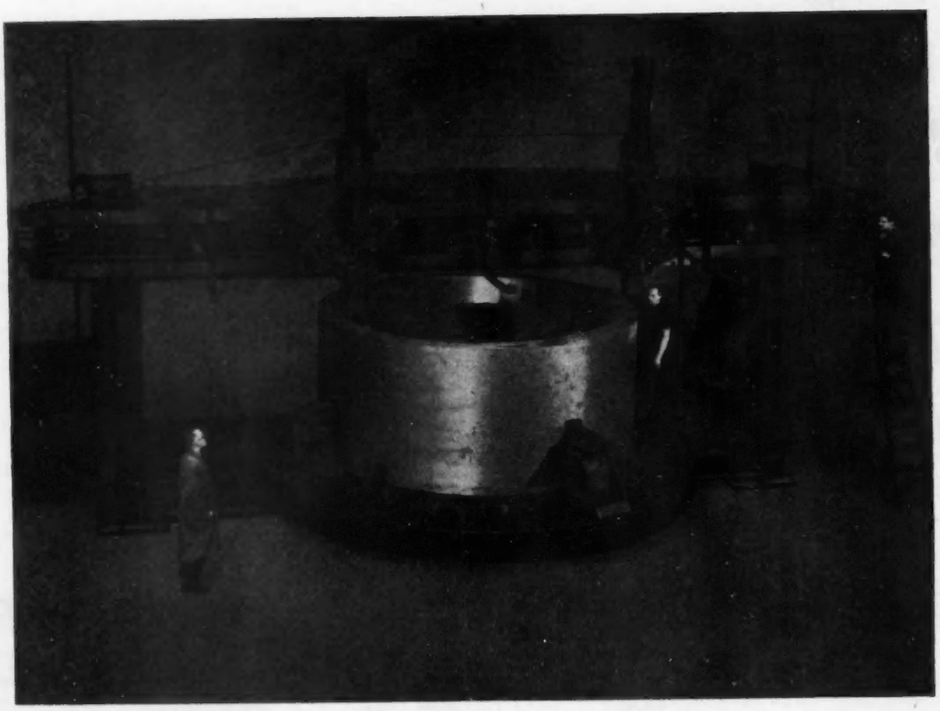

The Section of the Slab is 5′ 0″ × 10″

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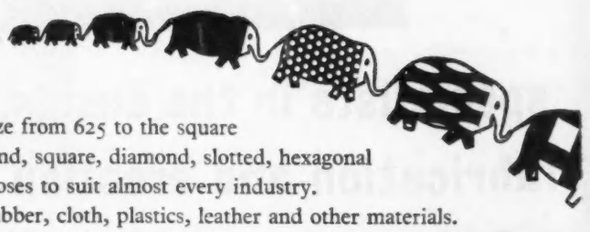
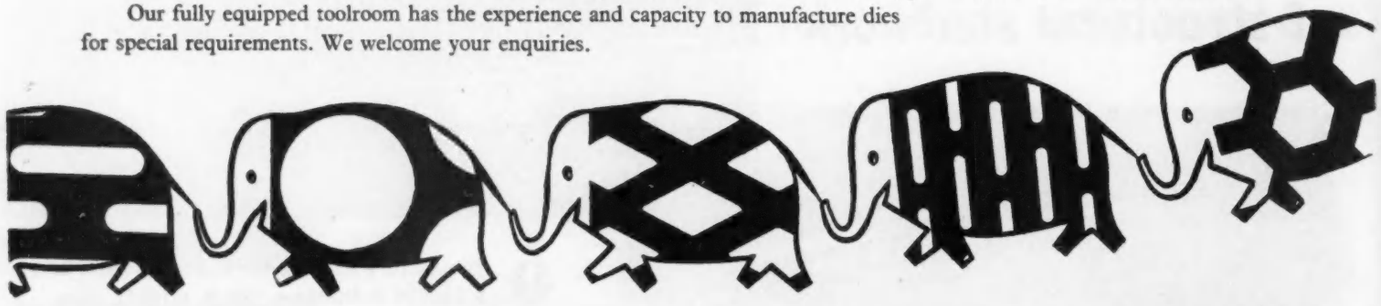


These are produced by Braby from standard dies. Round holes vary in size from 625 to the square inch to a diameter of 3 in. Steel and non-ferrous metals with round, square, diamond, slotted, hexagonal and oval perforations are manufactured by Braby for an immense variety of purposes to suit almost every industry.

We also perforate precious metals, paper, cardboard, rubber, cloth, plastics, leather and other materials.

Our fully equipped toolroom has the experience and capacity to manufacture dies for special requirements. We welcome your enquiries.



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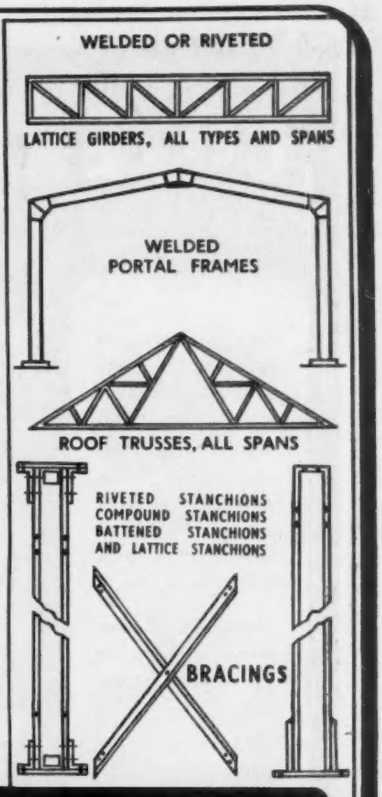

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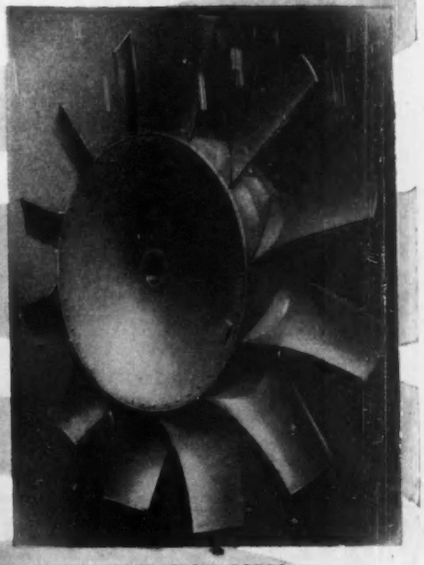

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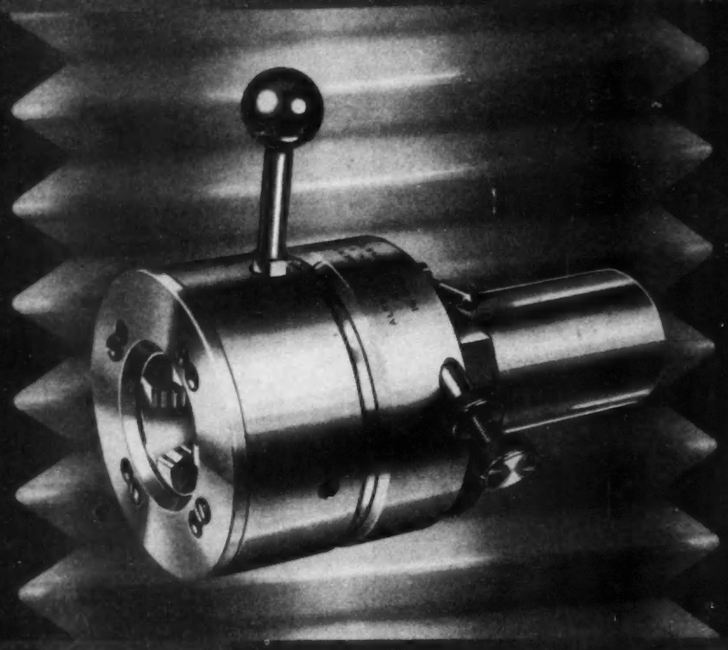

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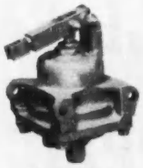

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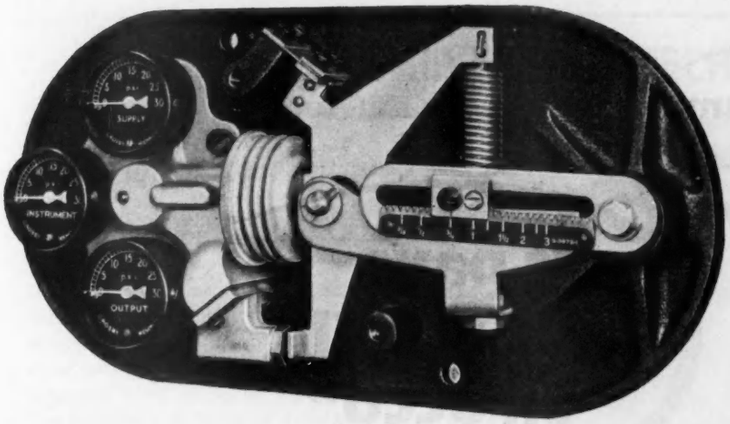
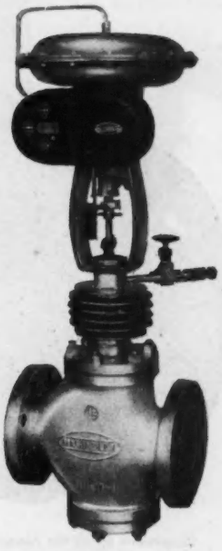


MASONEILAN CROSBY



7,000 Series Valve Positioners

The illustration above, depicting the inside of a standard Masoneilan Series 7000 Positioner, shows more vividly than anything how the design achieves a splendid simplicity so much desired by the user: the number of moving parts has been reduced to an absolute minimum. This in turn means ease of maintenance—the the pilot valve is removed by two screws and is dismantled by one more.

The characteristic ruggedness of the Crosby-Masoneilan instruments is present in the entire 7000 Positioner range. Working levers are of stainless steel; any danger of pivot friction and lost motion are eliminated by using a flecstrip bearing. The instruments are designed to stand up to working outdoors.

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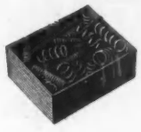
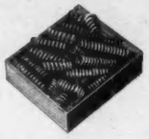
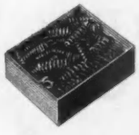


No. 1013. 1 gross Small Coil Compression Springs, ⅛" to 1½" long, 3/32" to 7/16" diam., 24G to 19G. 6/- each

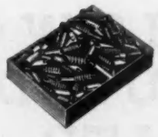
No. 760. 3 doz. Assorted Light Compression Springs 1" to 4" long, 22 to 18 S.W.G., ¼" to ½" diam. 6/6 each.



No. 98A. 3 doz. Assorted 1" to 4" long. ½" to ¾" diam. 19G to 15G. 5/6 each



No. 757. Extra Light Compression. 1 gross Assorted. ⅛" to ⅜", ½" to 2" long, 27 to 20 S.W.G. 15/- each.



No. 388. ½ gross Assorted Small Expansion Springs. ⅜" to 1½", 18G to 21G. 9/6 each.

No. 466. ½ gross Assorted Small Expansion Springs ⅜" to 1½" long, 3/32" to 3/16" diam., 21G to 24G. 6/6 each.

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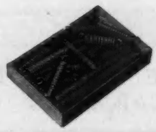
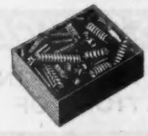


No. 753. 3 doz. Assorted Light Expansion ½" to ¾" diam., 2" to 6" long, 22 to 18 S.W.G. 10/6 each.



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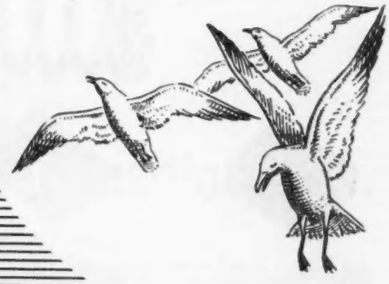

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The Type "D" Lubricator may be supplied with either a ratchet drive as illustrated or alternatively a rotary drive. Either style of drive can be fitted either right or left hand and also can be placed at the back of the Lubricator.

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6 FEED
4½ PINT CAPACITY
R.H. RATCHET DRIVE

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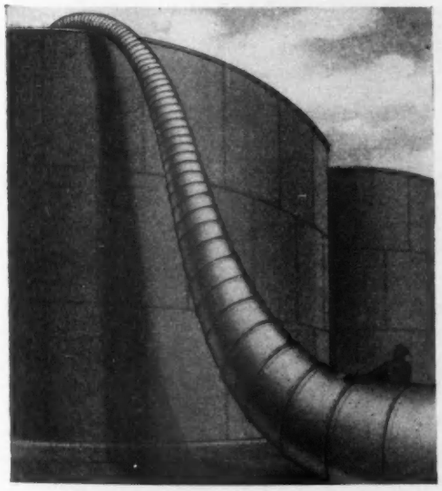

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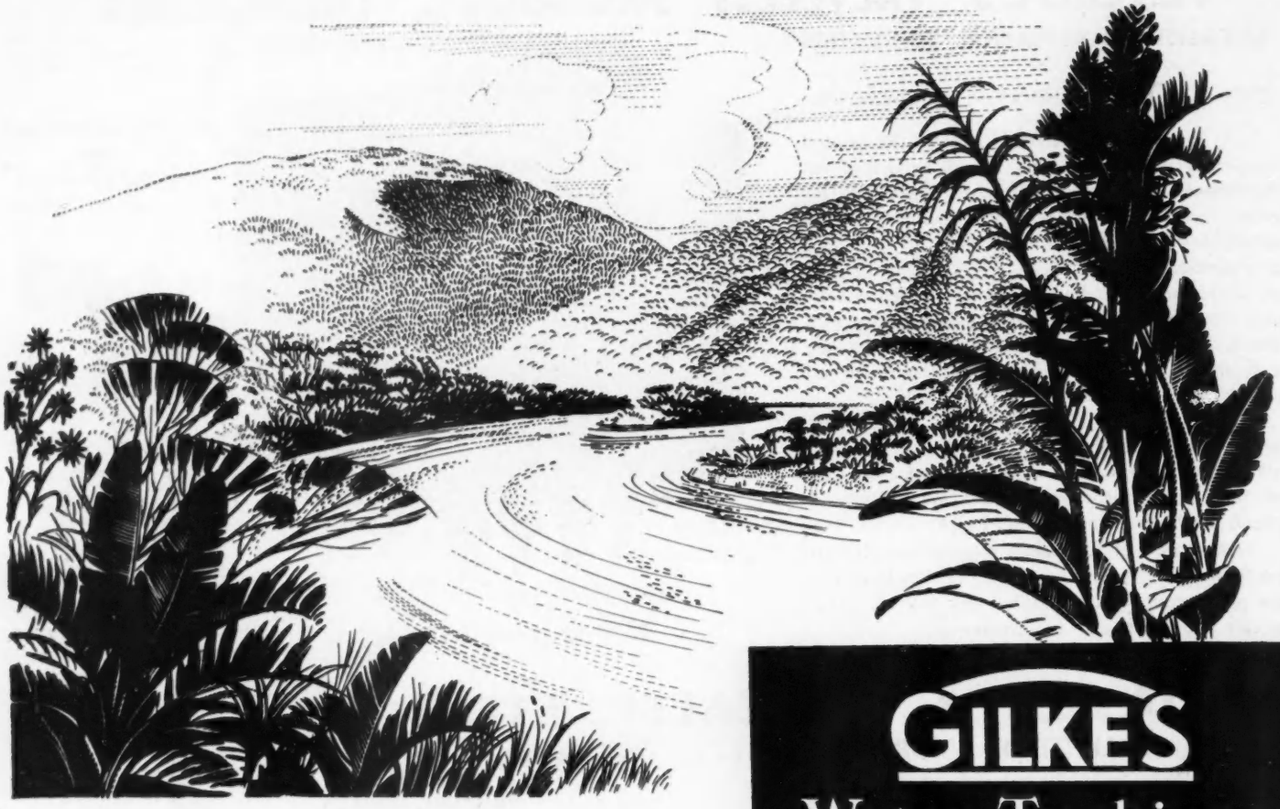

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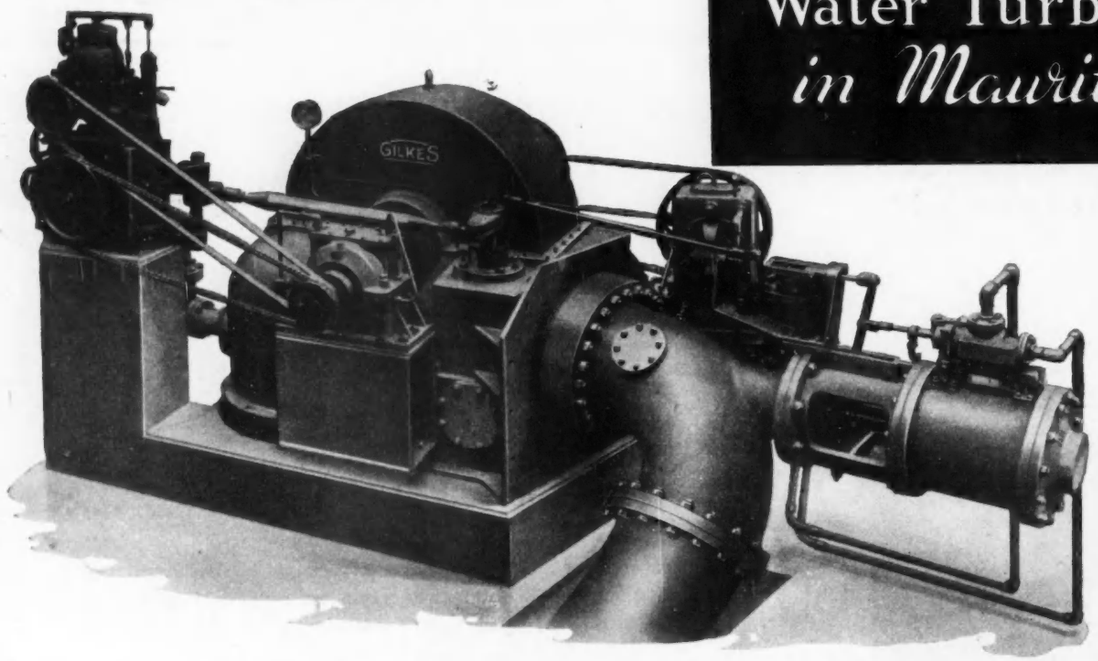
Water Turbines *in Mauritius*



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It is installed at the Curepipe Power Station of the General Electric Supply Company, Mauritius, driving a 3750 kVA alternator. Two smaller GILKES Turgo Impulse Wheels each developing 3000 B.H.P. are operating in the same power station.

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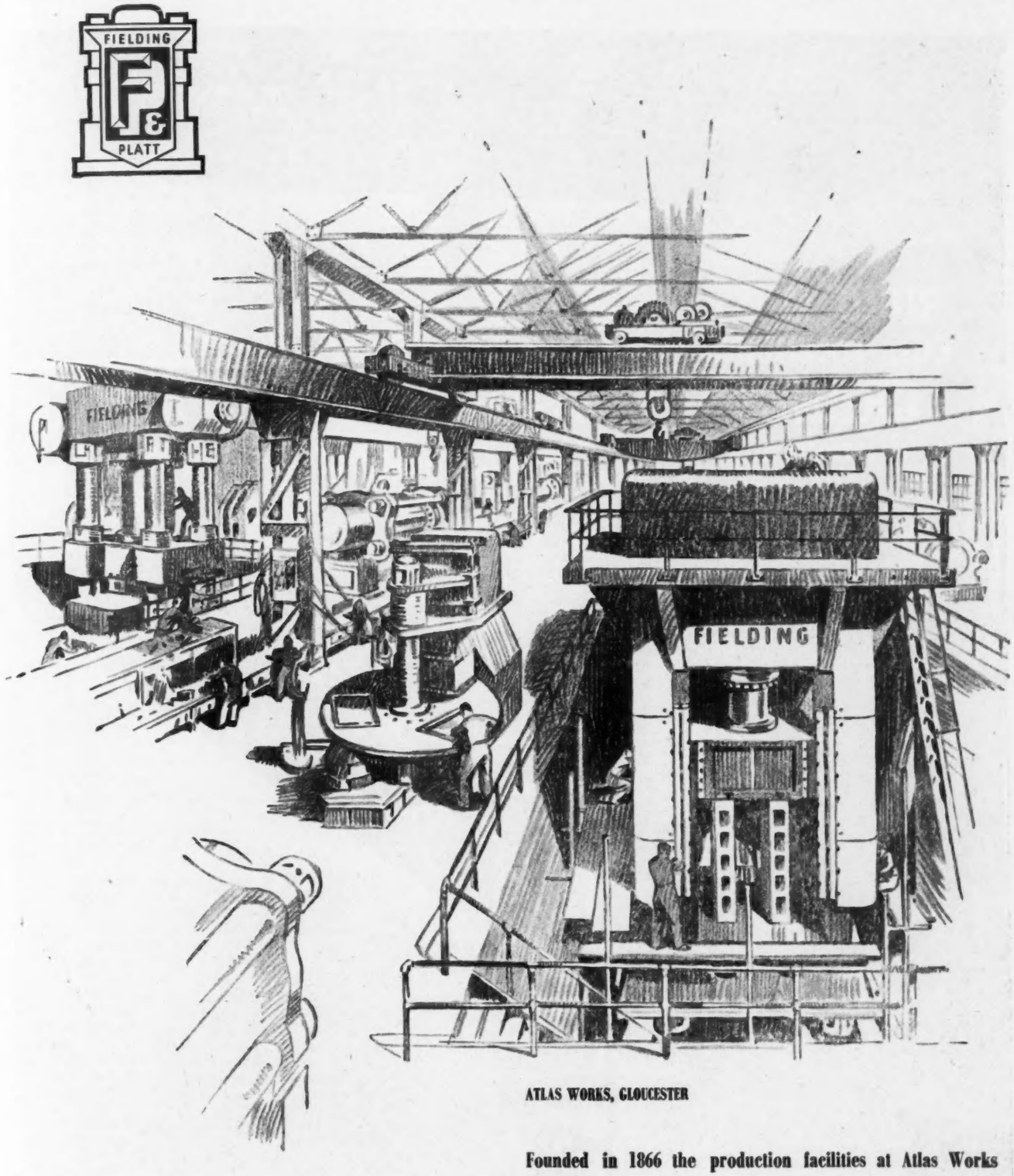

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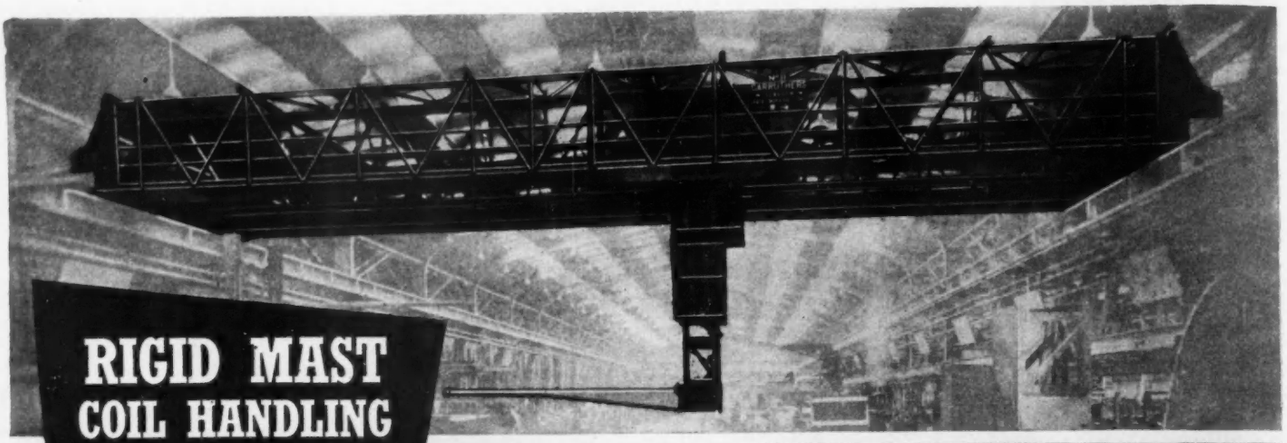

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AS SUPPLIED TO I.C.I. KIRKBY WORKS

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The Crane illustrated is one of 16 supplied to I.C.I. Kirkby Works.

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by

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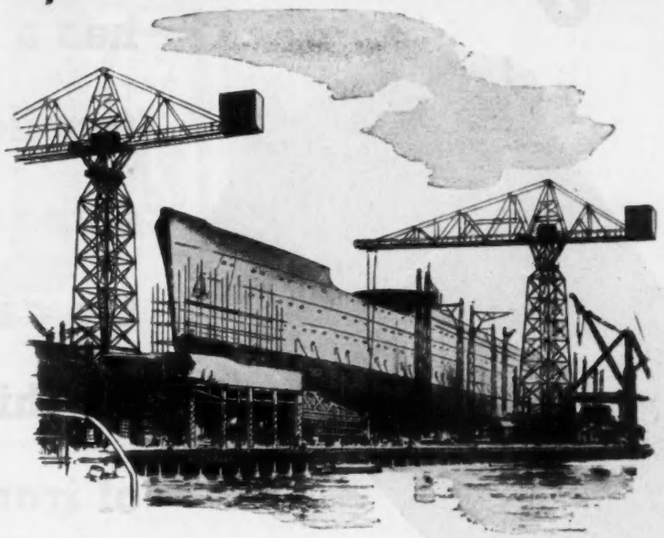

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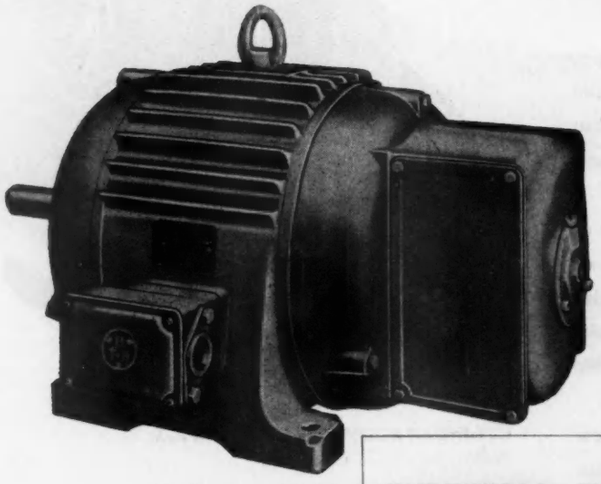

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has a greater tensile strength than some steels with the castability and machineability of iron

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PEARLITIC	35–45	25–35	1–5	55–65	65–80	4	230/280
PEARLITIC/FERRITIC	32 min.	24 min.	5 min.				
FERRITIC	27/35	20/25	10/25	55/60	48/58	12	140/180

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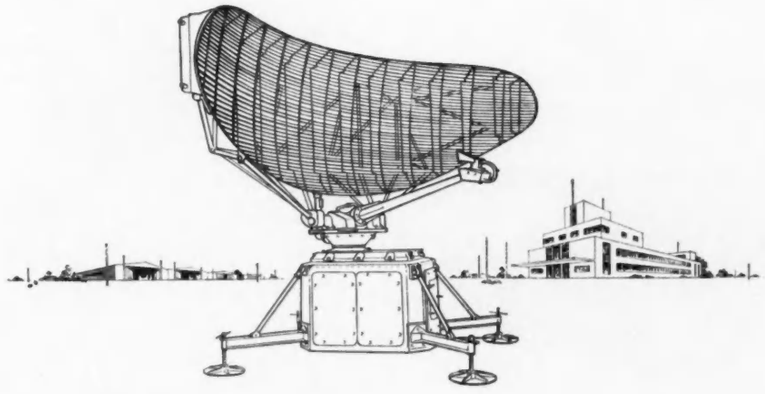

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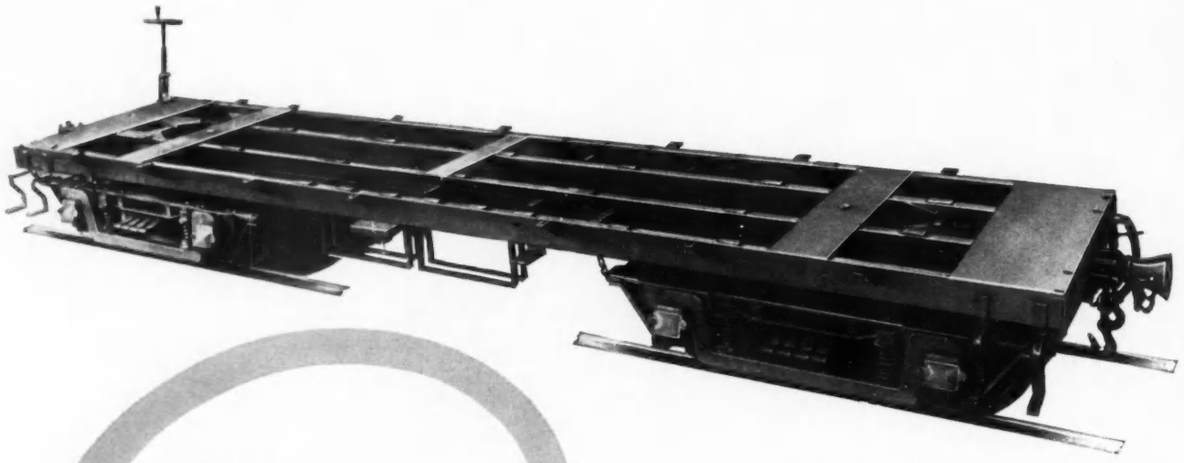

Overhead view of complete underframe

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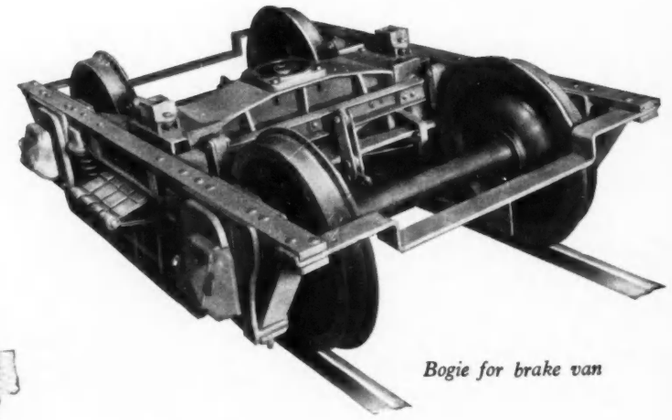
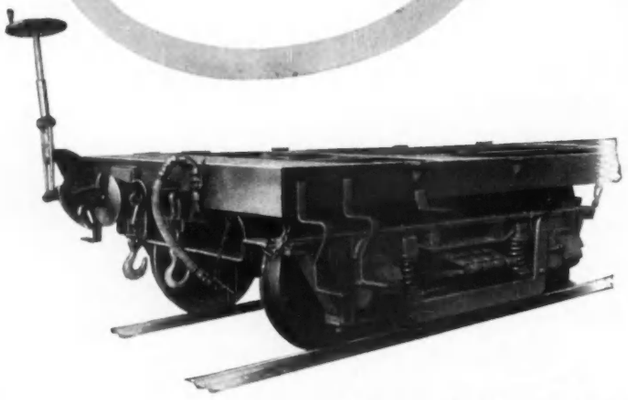
Class "F" Underframes and Bogies for Brake Vans



Bogie for brake van



Close-up view of handbrake end

The underframes have been built for operation on 3ft. 6in. rail gauge. The length of the complete underframes over headstocks is 30ft., while the length over couplers is 32ft. 8½in. Wheel diameters are 2ft. 6¼in., on tread. Westinghouse air brake and handbrake are fitted.

THE BUTTERLEY COMPANY LIMITED · RIPLEY · DERBY · ENGLAND · Tel: RIPley 411 (9 lines)

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W5A

Teddington

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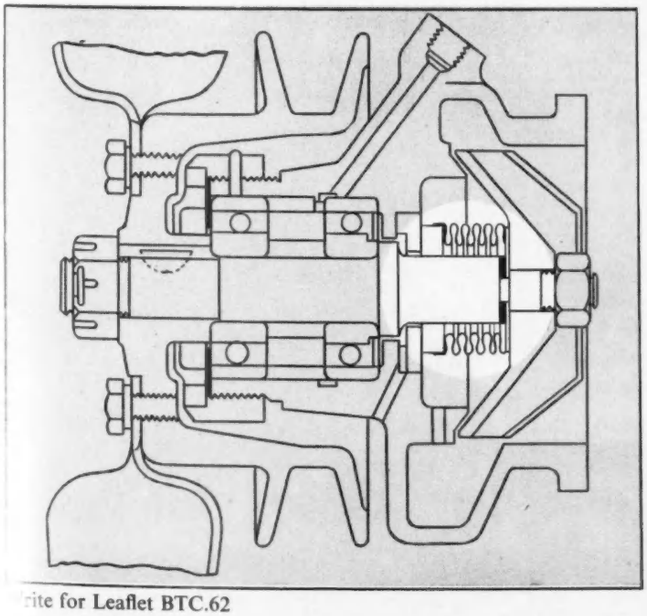
Photograph by courtesy of London Transport Executive

TEDDINGTON Shaft Seals are ideal for shafts running at speed. For example a $3\frac{1}{2}$" dia. shaft running at 2000 R.P.M. in temperatures up to 300°F is quite normal. As peripheral speed of the rubbing surfaces is the deciding factor, they can be fitted to larger shafts running at lower speeds, or to smaller ones at high speeds. They will retain most liquids or vapours at pressures from 30-in. vacuum to 250 lbs. per sq. in., and are unaffected by continuous or intermittent running, or reversing.

... for effective sealing against most liquids and gases



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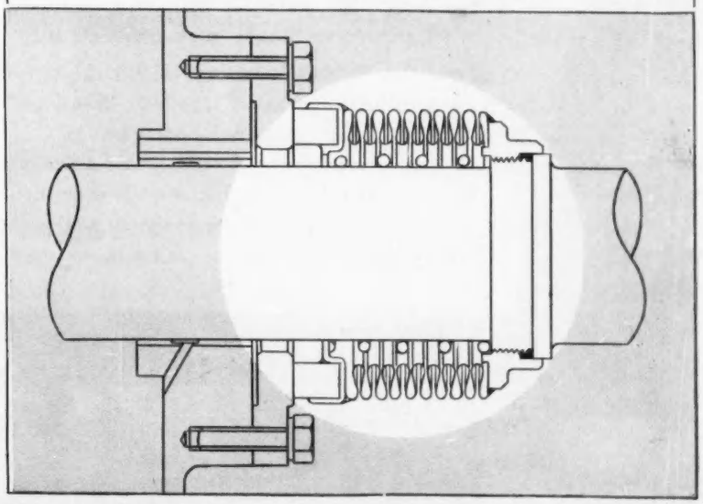
DURING THE PAST 25 YEARS



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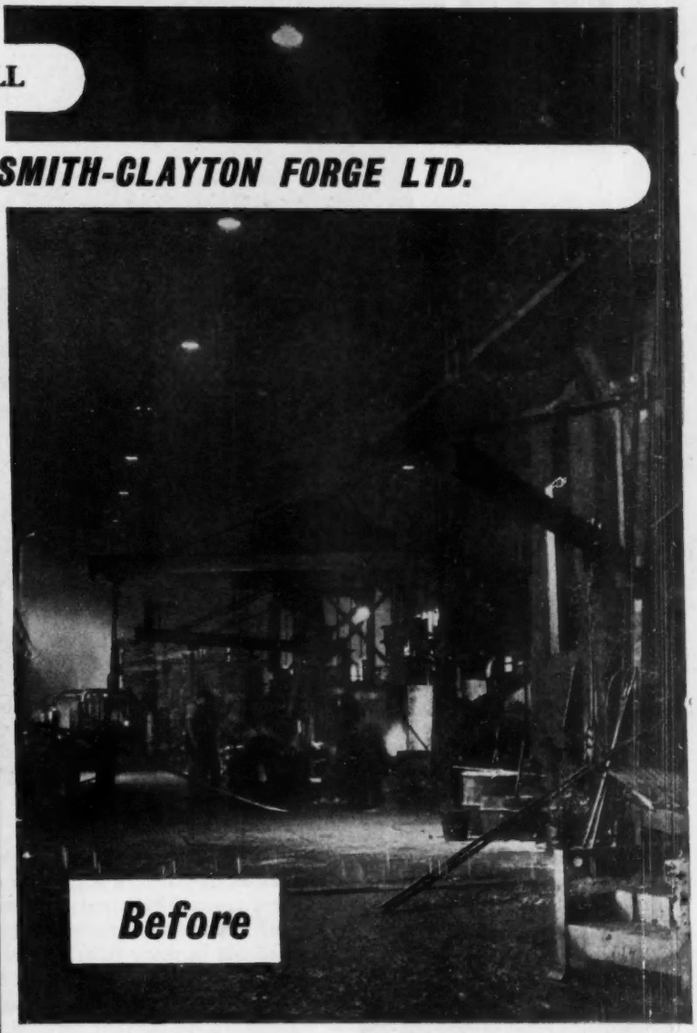
British Oxygen Gases Ltd., Industrial Division, Bridgewater House, St. James's, London, S.W.1.

SEE WHAT COLT VENTILATION DID FOR US

says

MR. H. KENDALL

Works Engineer of **SMITH-CLAYTON FORGE LTD.**



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Travelling Cranes with a span of 40'
to travel along a common gantry 76' long.
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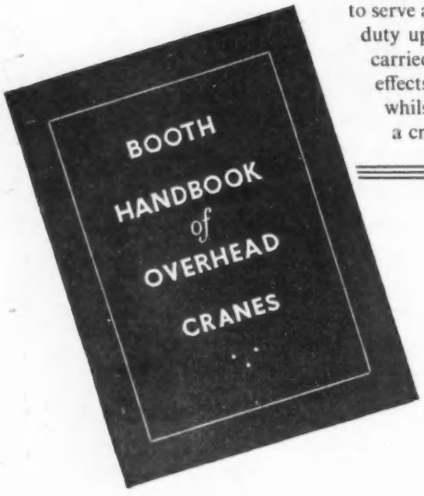
a BOOTH standard electric overhead crane will DO THE JOB!

THE Booth method of classifying overhead electric travelling cranes to suit varying service factors means that from a range of five classes of cranes, it is possible to offer a standard crane to serve almost any industrial requirement. We manufacture cranes for light duty up to continuous process cranes for Steelworks, and installations within this range have been carried out in many factories and Steelworks in this country and abroad. Grading of cranes effects considerable economies by making it possible to standardise components within each group whilst still retaining the advantages from the purchaser's point of view of being able to choose a crane to suit the duty required.



The Booth Handbook of Overhead Cranes is a comprehensive publication containing practical information which will be of interest to crane users. It fully explains the Booth method of classifying overhead cranes to suit varying service factors and gives detailed information and hints on fixing crane particulars which would be of assistance to any firm contemplating additional craneage.—

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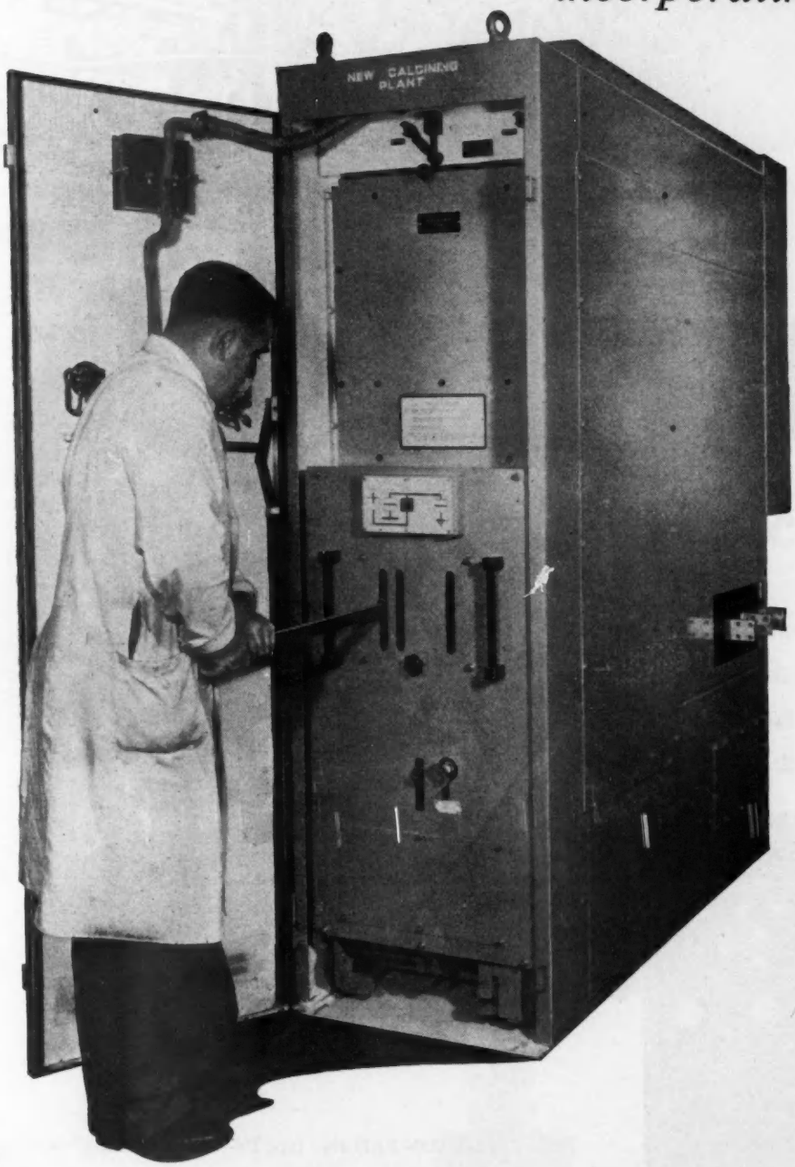

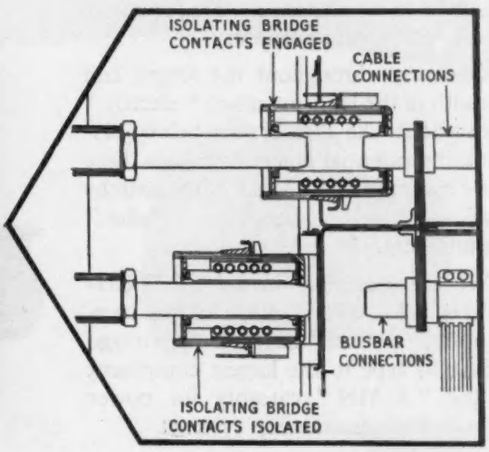

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With the 'Isolector' mechanism it is no longer necessary to withdraw the truck from the cubicle to isolate the breaker. Isolation facilities, together with the cable earthing switch fitted to each unit, are all readily operated from the foolproof interlocking gate at the front of the unit.

The 'Isolector' mechanism simplifies busbar selection in duplicate busbar units. These are available in the same cubicle dimensions as single busbar units.

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The ratings for Class 'E' Switchgear are: Breaking Capacity—150 MVA at 3.3 kV, Maximum service voltage—3,300 volts, Maximum current rating—2,000 amps. The gear is housed in a handsome, dust-proof cubicle and has excellent main and multi-core cabling facilities.

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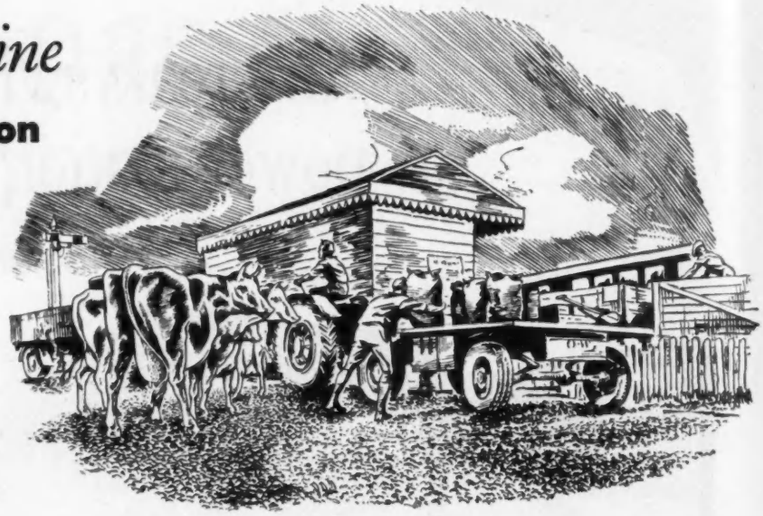
WORKS: STAFFORD · PRESTON · RUGBY · BRADFORD · LIVERPOOL · ACCRINGTON

Somewhere down the line

— is a busy little station



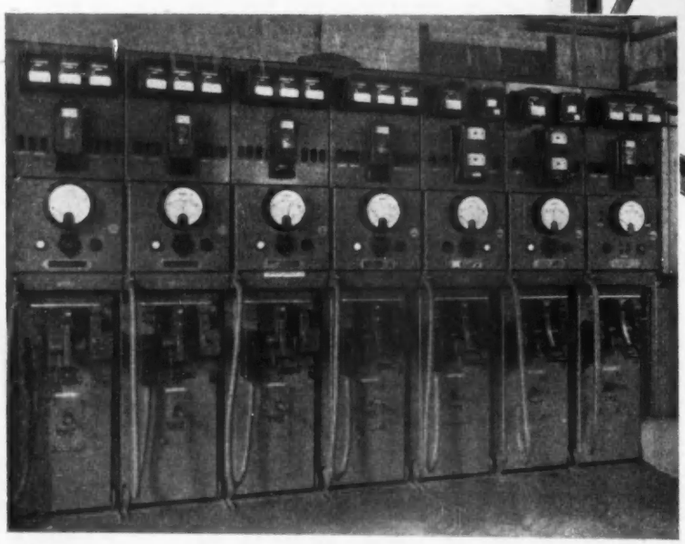
—a receiving depot for an established system of transport which brings to a growing community the food, raw materials and manufactured goods essential to its existence. This is one of many with a vital purpose.

Similarly, throughout the length and breadth of the land, are many " electric " substations like that shown below, distributing essential power supply to these same communities. Much of the switchgear is of " Ferguson Pailin " manufacture.

We are specialists in the SWITCHGEAR field, with a range of products stepping up from the medium voltage industrial type to the largest equipment in the " MAIN " category for power stations and transmission systems.

All receive the same expert attention throughout production—it is therefore well worth while to specify " Ferguson Pailin " when the need is for SWITCHGEAR.

Type OFS/IB3—11kV extensible ring-main equipment for indoor or outdoor service.



A typical type BV—11kV switchboard.

This ' FERGUSON PAILIN ' type BV—11 kV metalclad switchgear, with adequate protection against fire risks, is designed for extension to similar, or other, switch units/isolators as required. Circuit-breakers are interchangeable, each contained in its own truck, with easy access for inspection and maintenance purposes.

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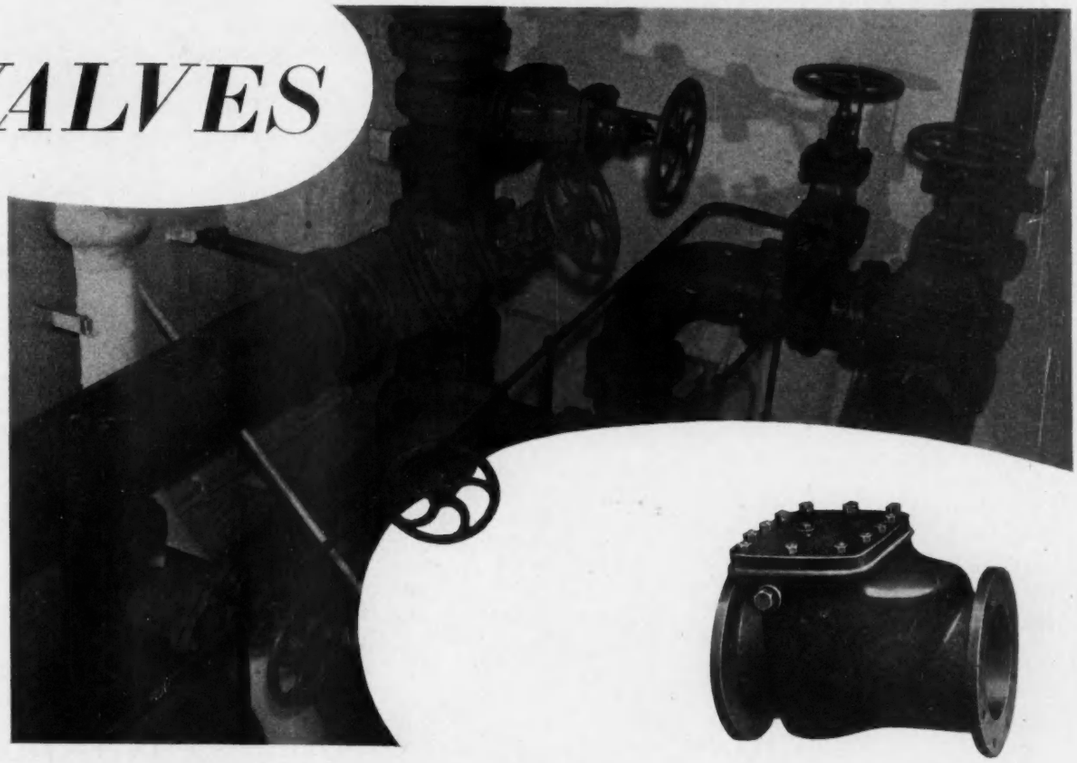

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all requirements for valves to control the flow of fresh or sea water, or oil, in circulating water systems; bilge, ballast and domestic services; wash deck, oil fuel and tanker cargo lines, etc., can be readily met from the Glenfield valve range.

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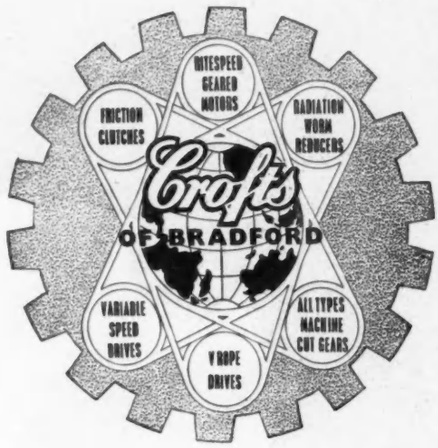

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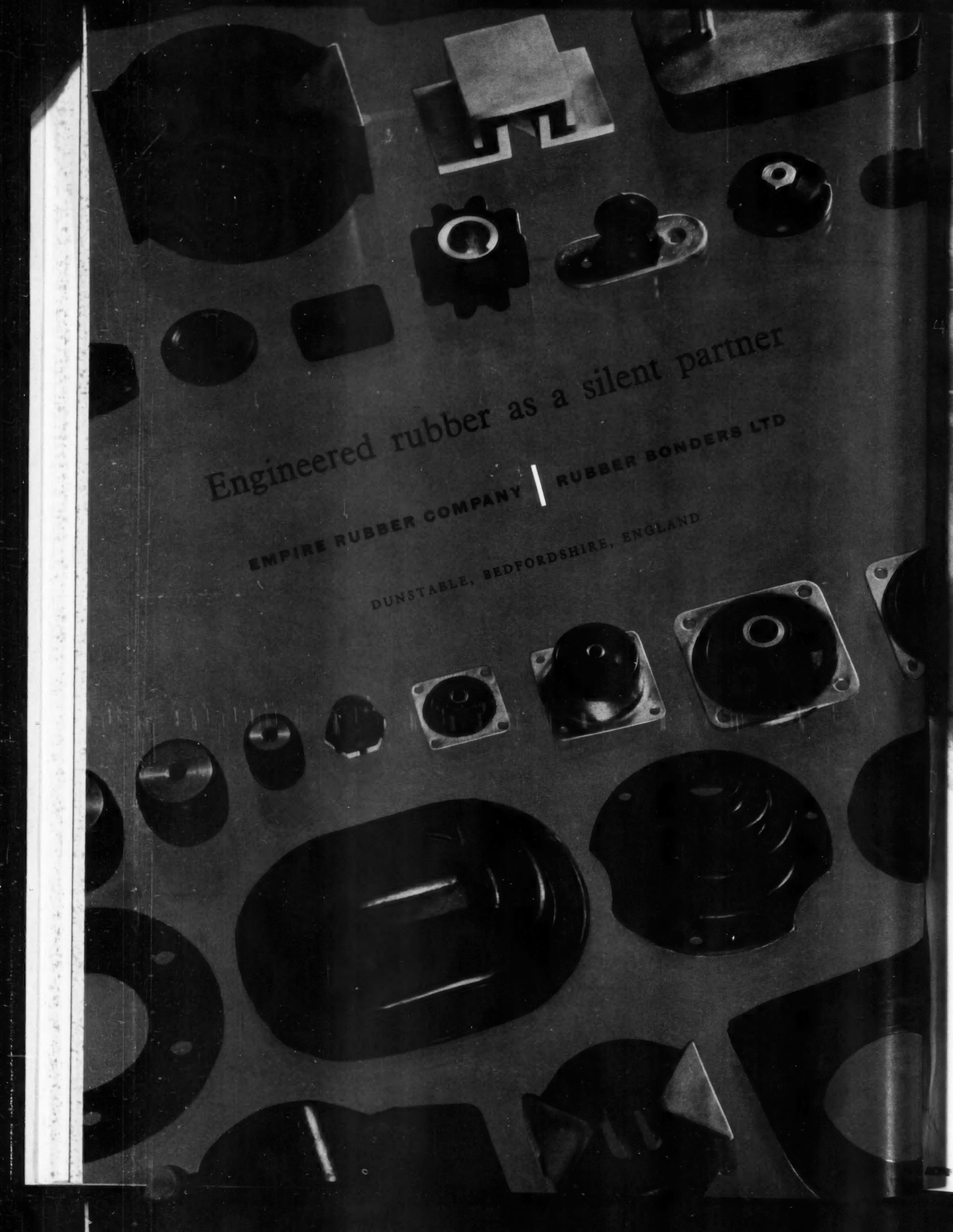
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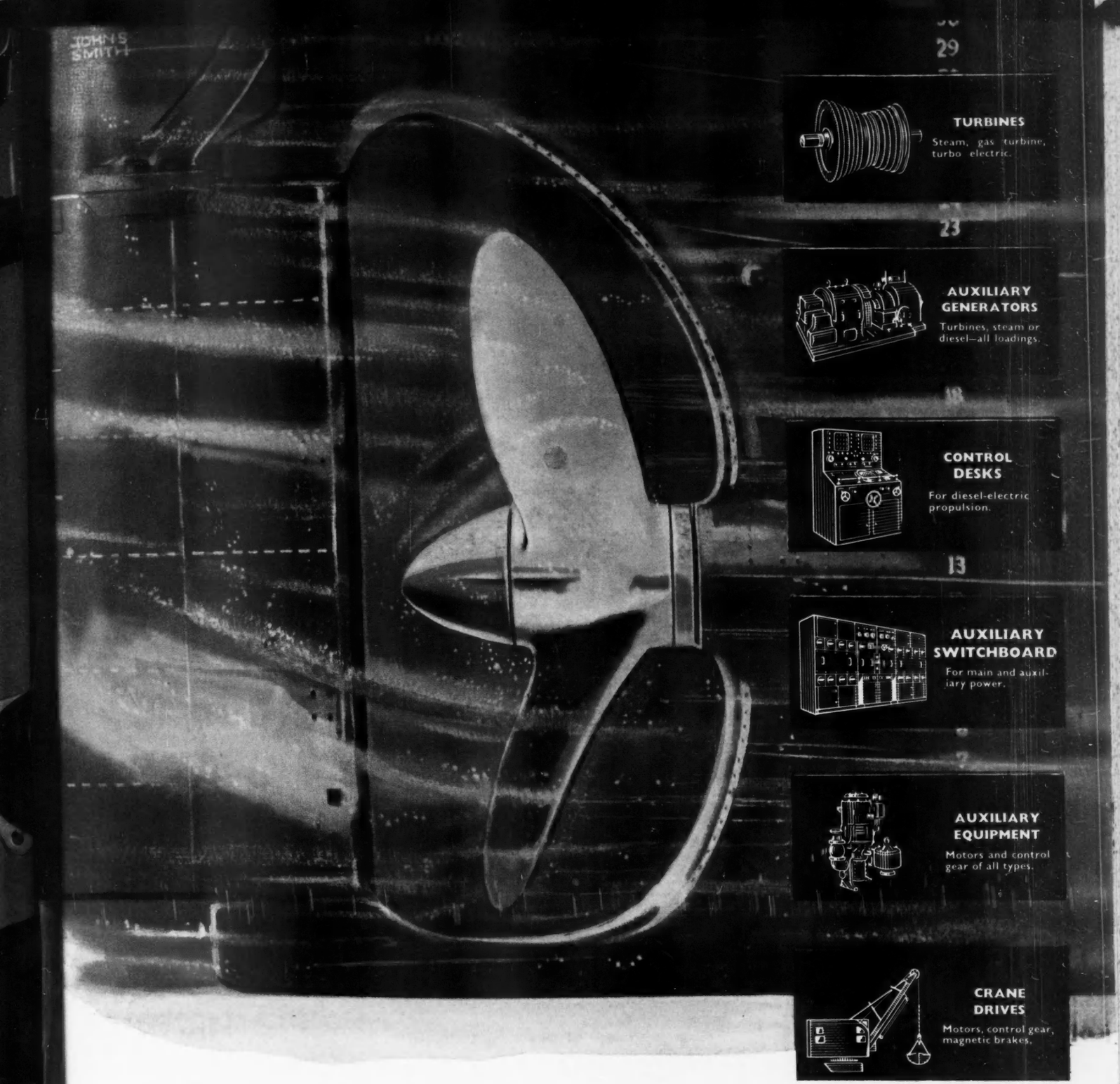

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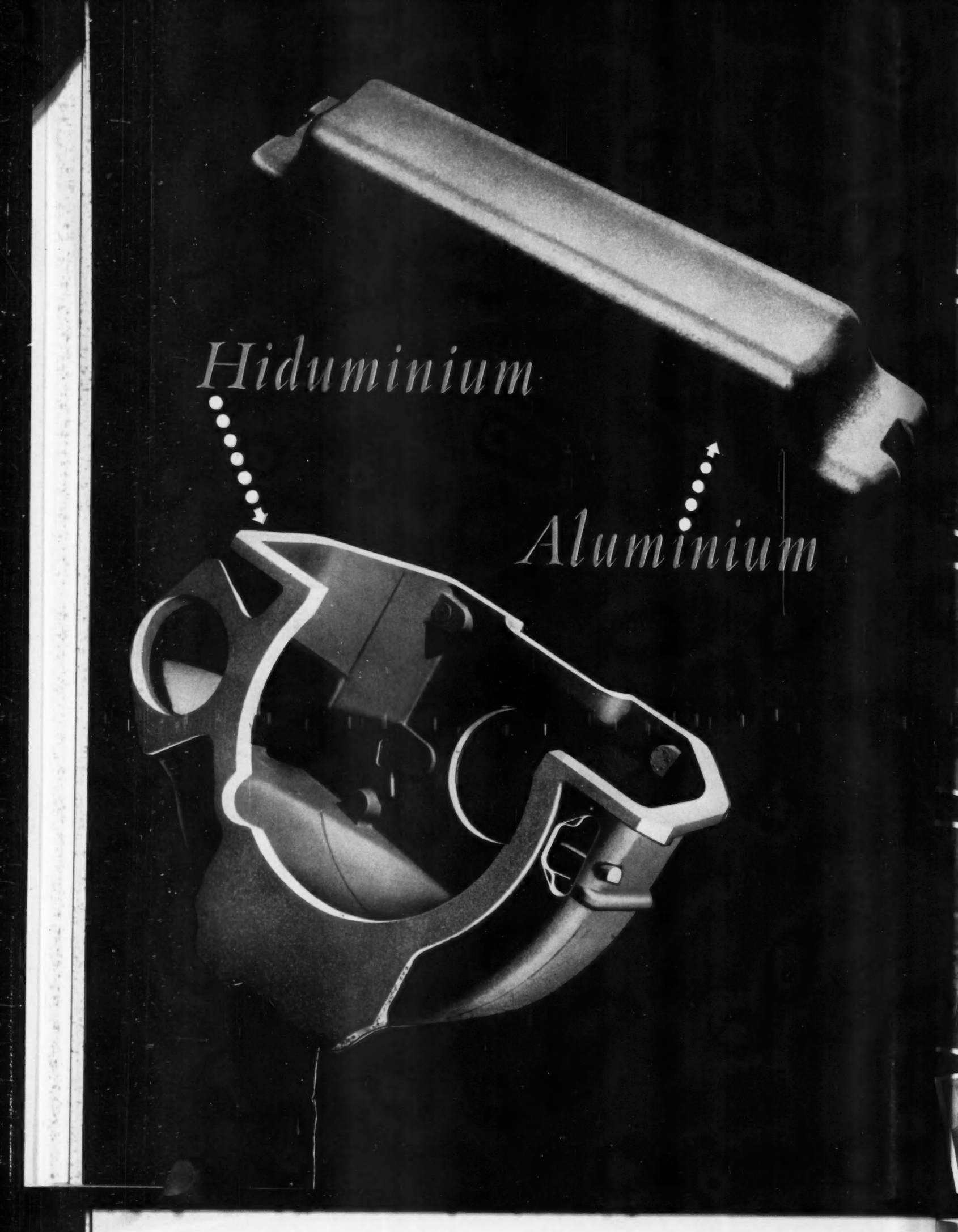
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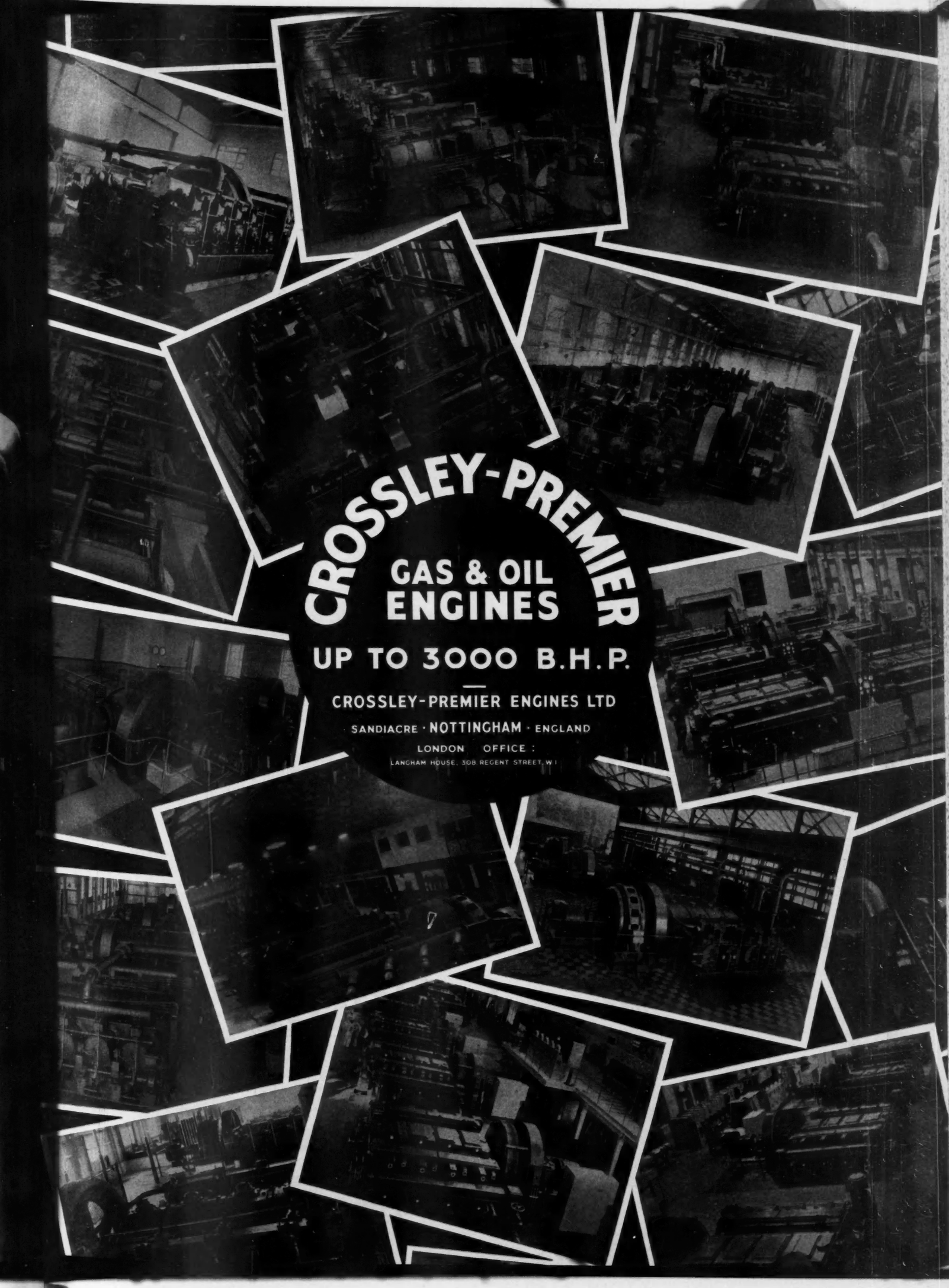
Aluminium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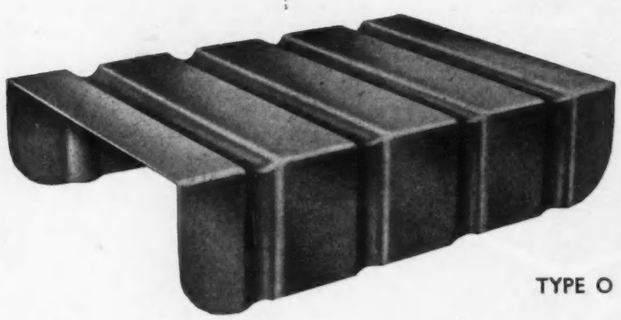

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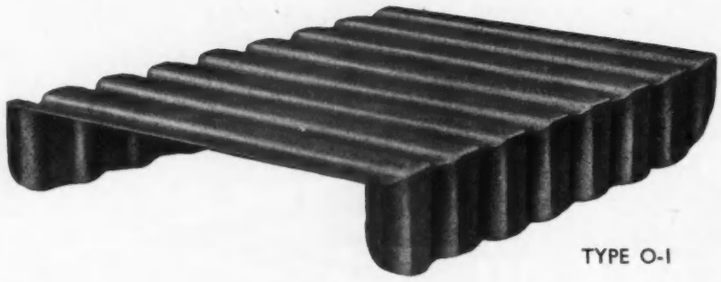
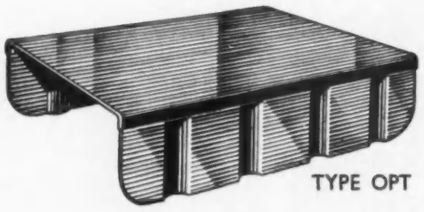
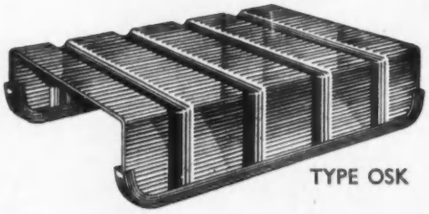


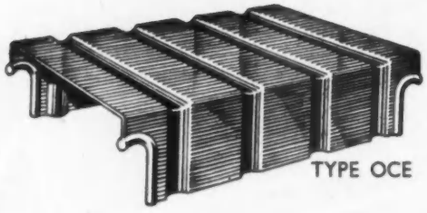
TYPE O-I



TYPE OPT



TYPE OSK



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There are no projections to get in the way and nothing to work loose.

Where a flat top surface is required, the platforms can be supplied fitted with plain M.S. or aluminium covers as Type OPT illustrated on left. They are also available with skids to permit sliding over floors (Type OSK), or with ends cut away for slinging (Type OCE).

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QUOTATIONS AGAINST SPECIFICATION. Please state pattern, load to be carried, type of truck, height and width inside corrugations and length.

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● *Design based on swinging motion of the pendulum*

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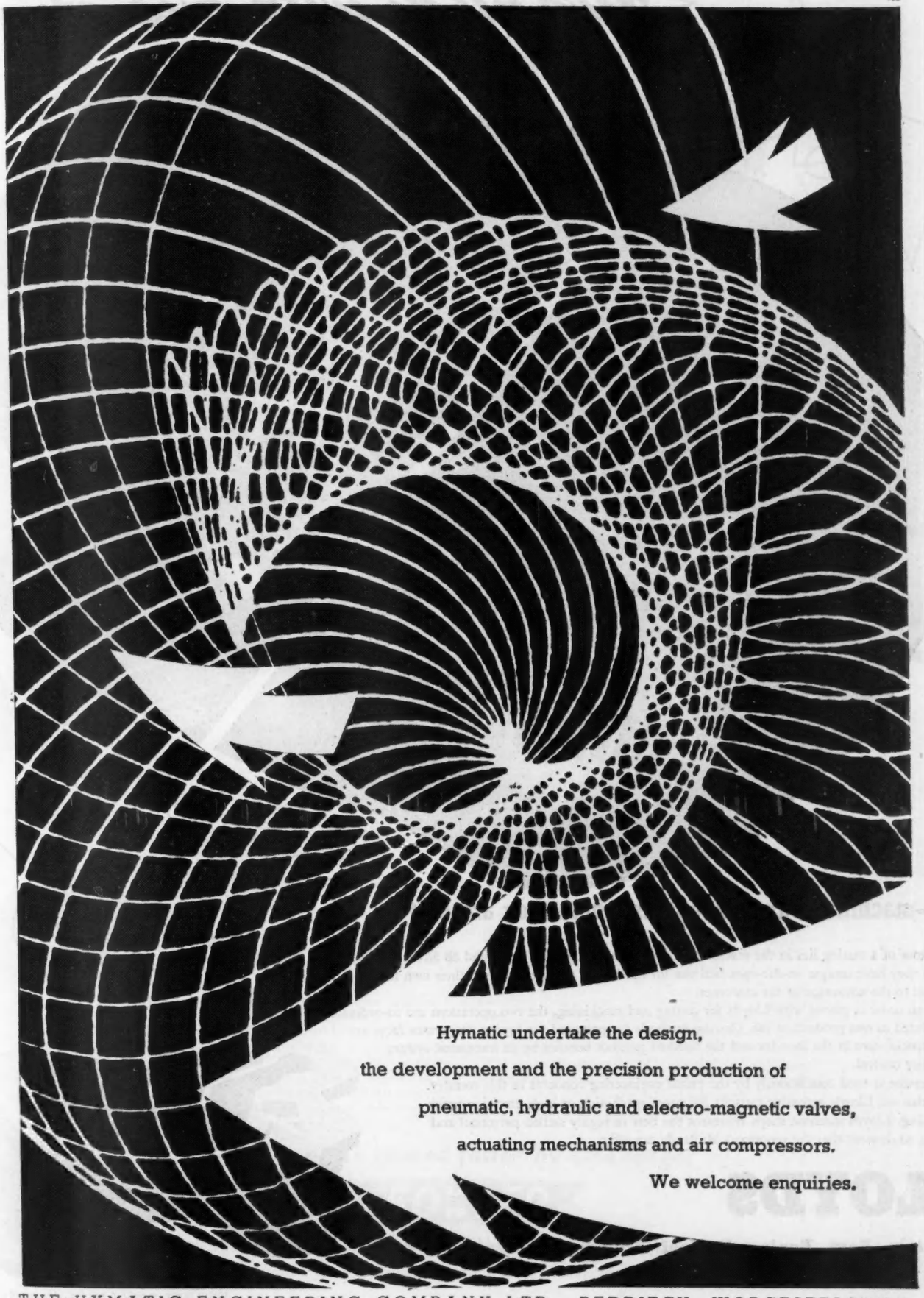

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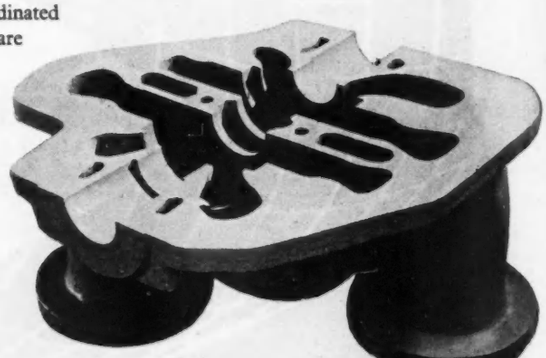
This service is used continuously by the prime engineering concerns in this country. They also use Lloyds extensive capacity for proof machining or high precision finish machining. Lloyds machine shops represent the best in highly skilled personnel and modern equipment that the renowned Midlands can offer.



PUMP BODY, *weight 1,230 lbs., dimension 2' 11½" x 2' 8" x 1' 8½". Cast for Sigmund Pumps Ltd.*

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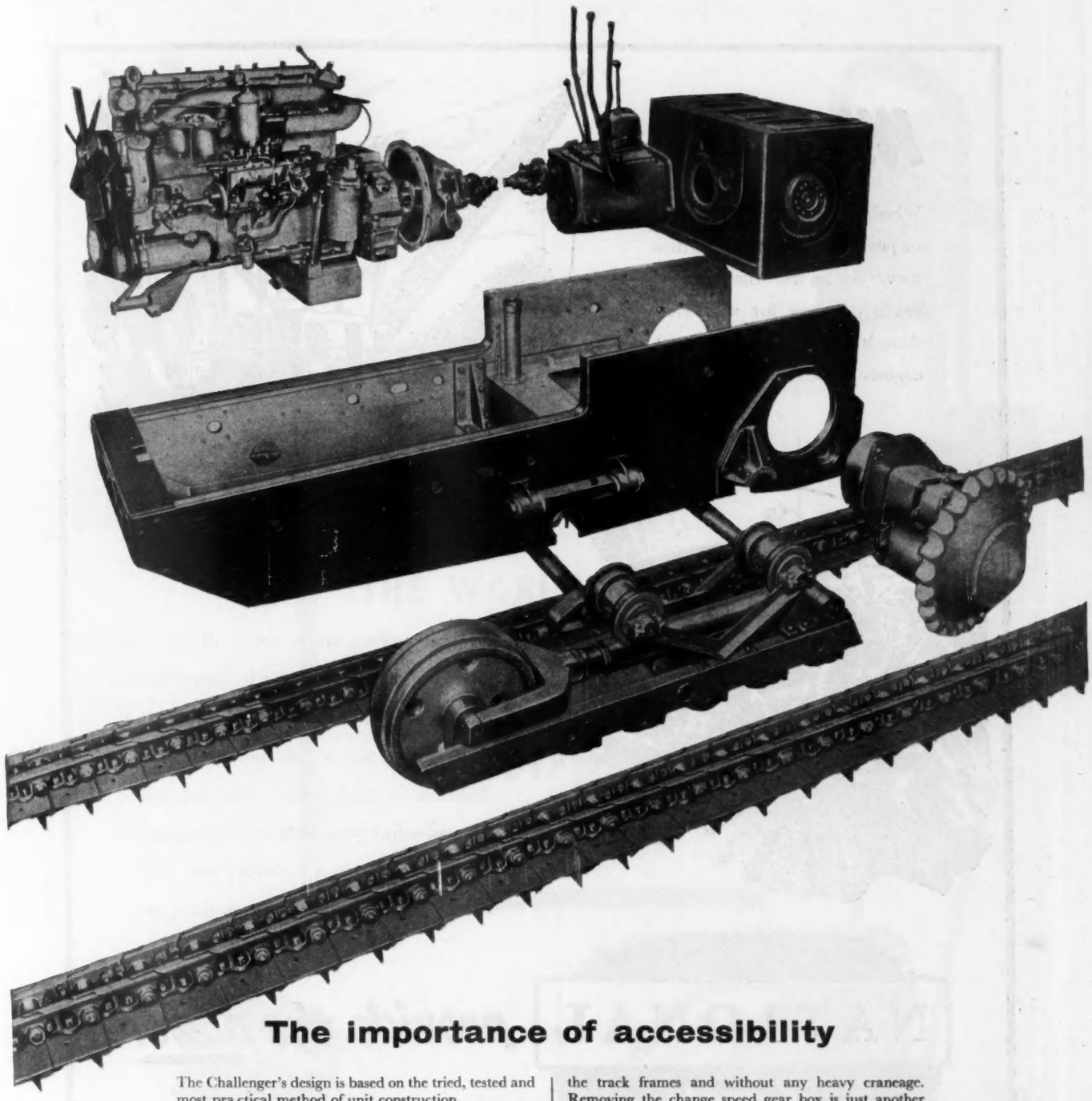

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More earth moved faster by Challenger

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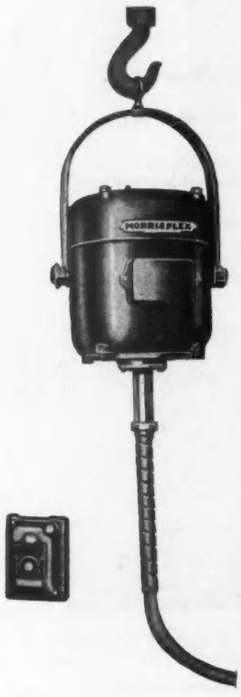

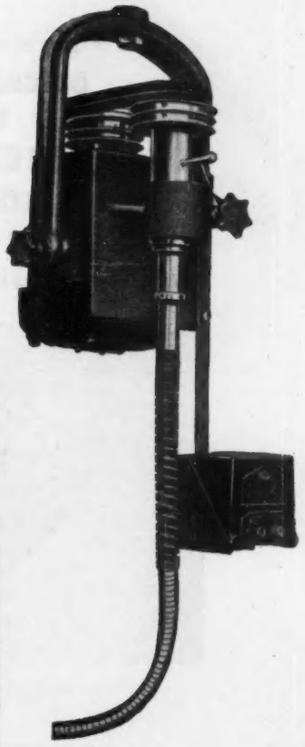

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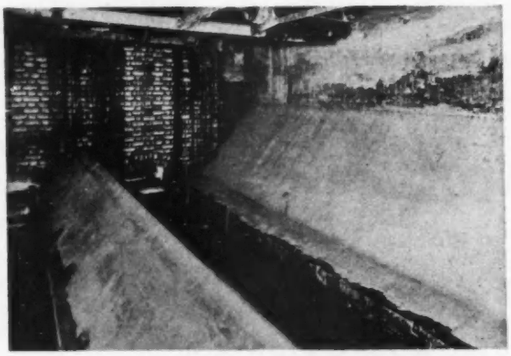
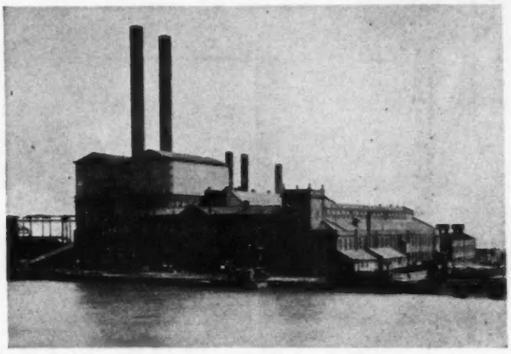
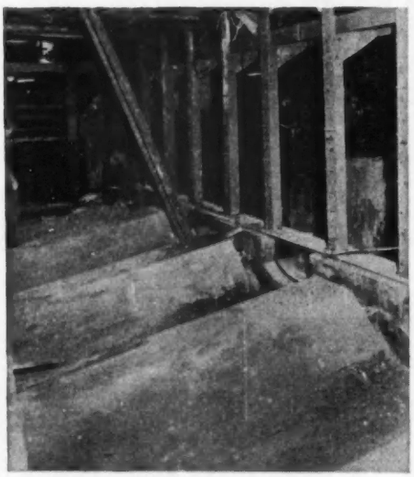


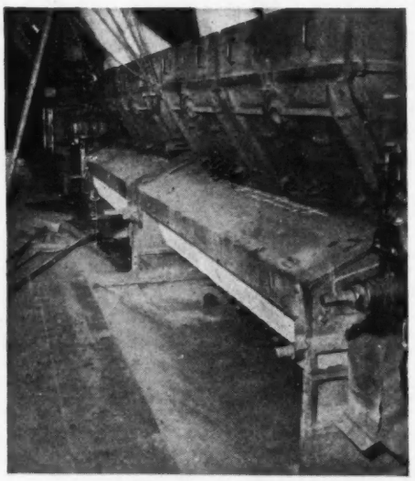
Clarence Dock Power Station. Hopper lined with ordinary Ciment Fondu concrete and the brickwork pointed with Ciment Fondu mortar.



Brighton 'A' Power Station. Ash pits and chimneys lined with ordinary Ciment Fondu concrete.



*Battersea Power Station. Ash Hopper Foundation of *Refractory Concrete designed to catch the hot burnt out ash falling from the boiler grate and wash it into the ash race. Overall size is 34' by 15' 6" by 4' 2".*



Acton Power Station. Hopper beneath chain grate stoker lined with ordinary Ciment Fondu concrete. Linings are 12' long by 2" and extend the full width of the grate.

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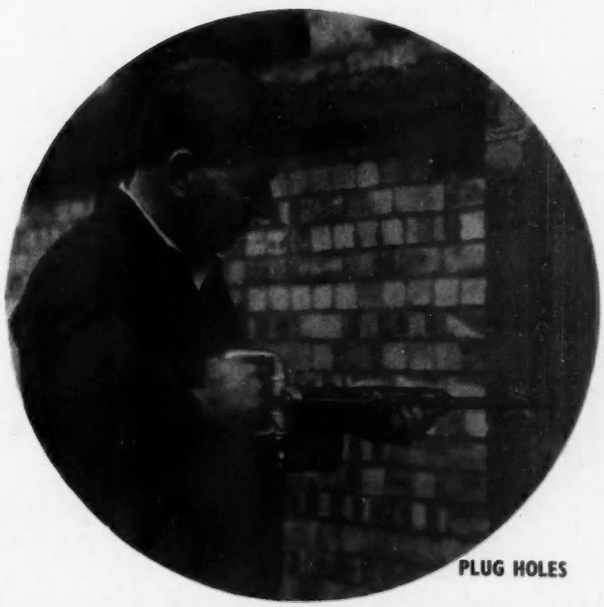

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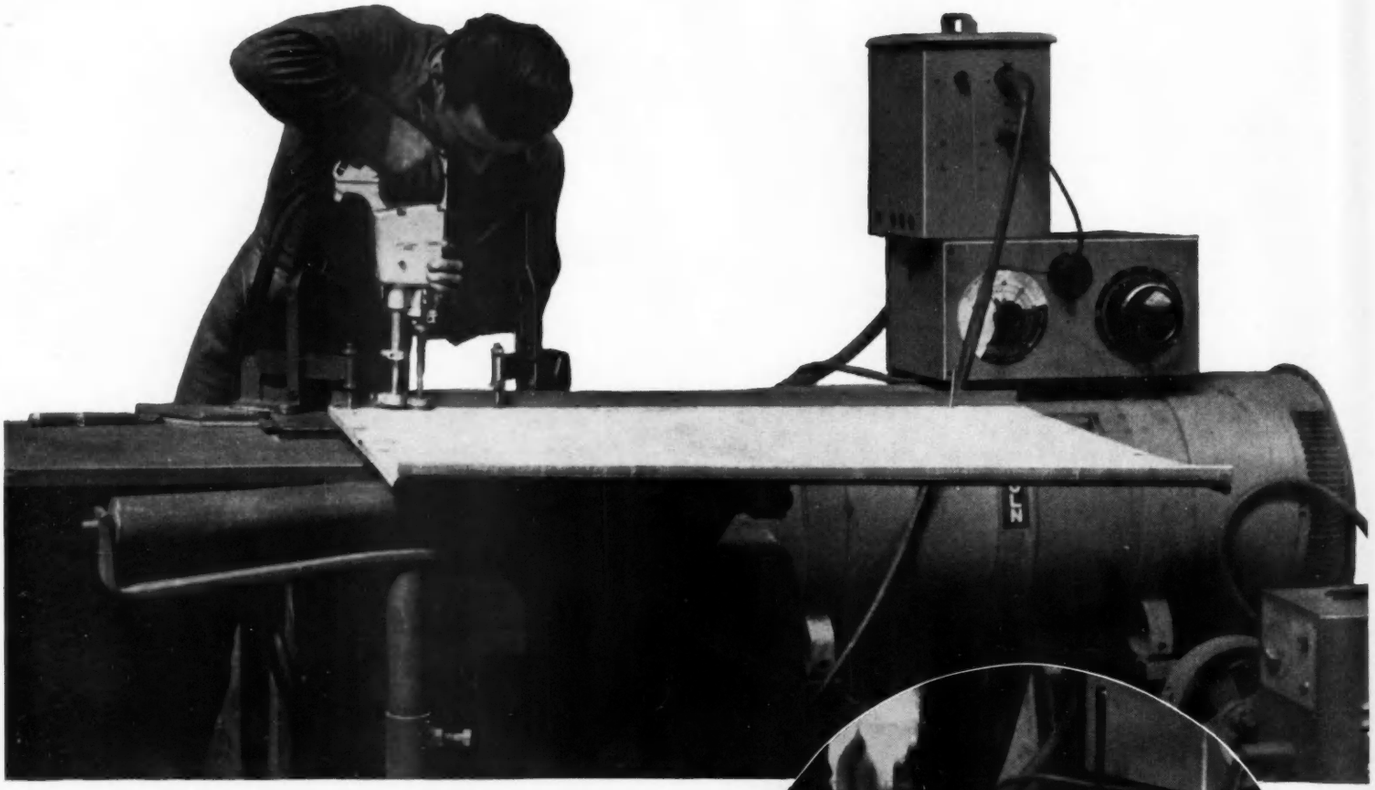

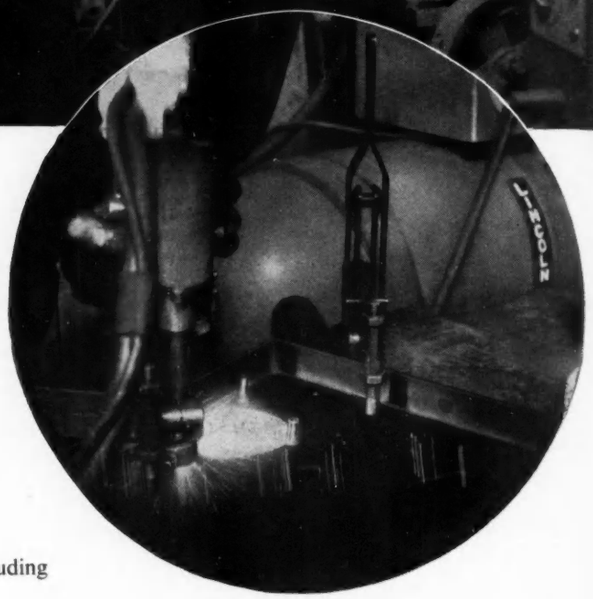

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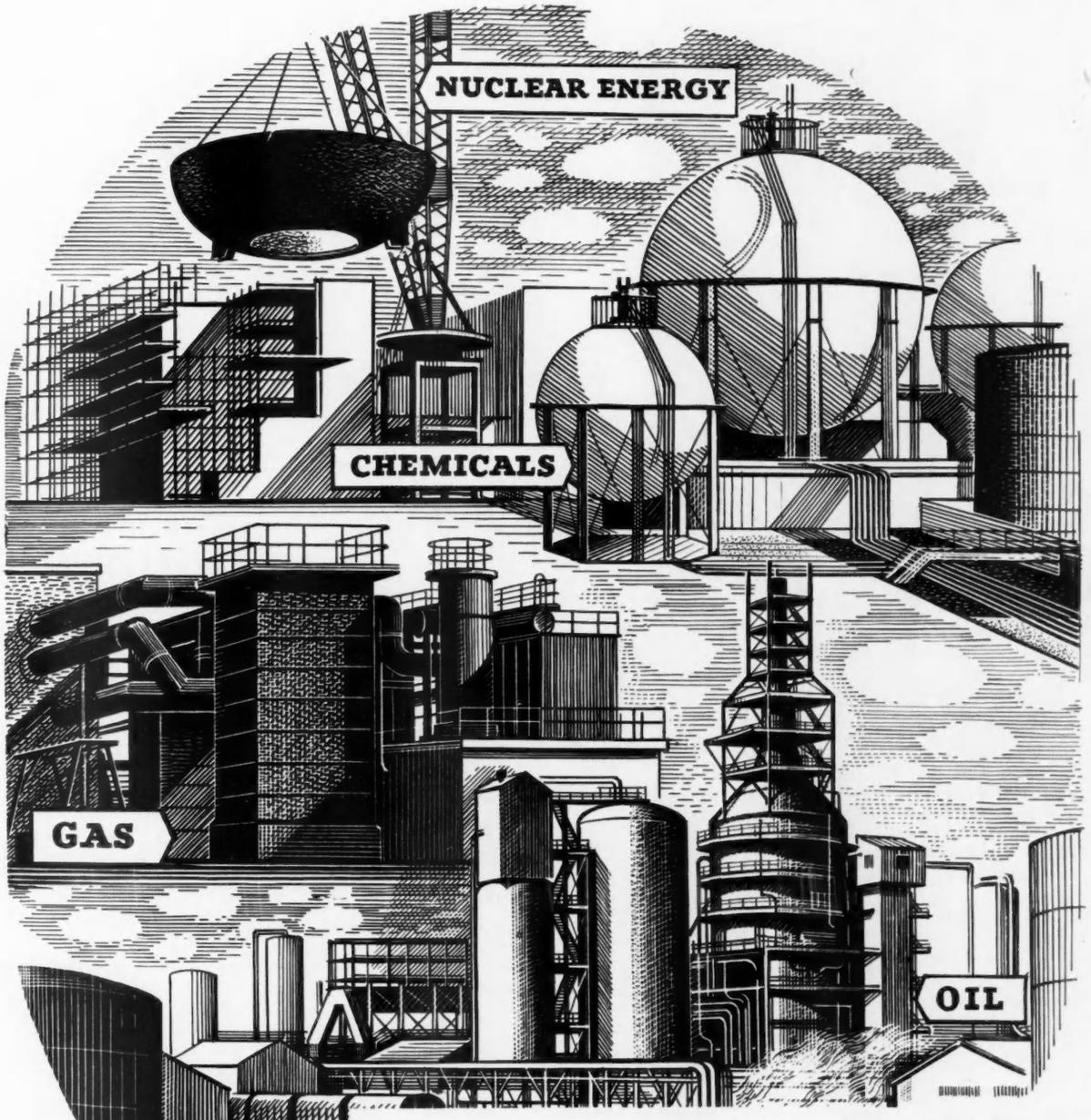

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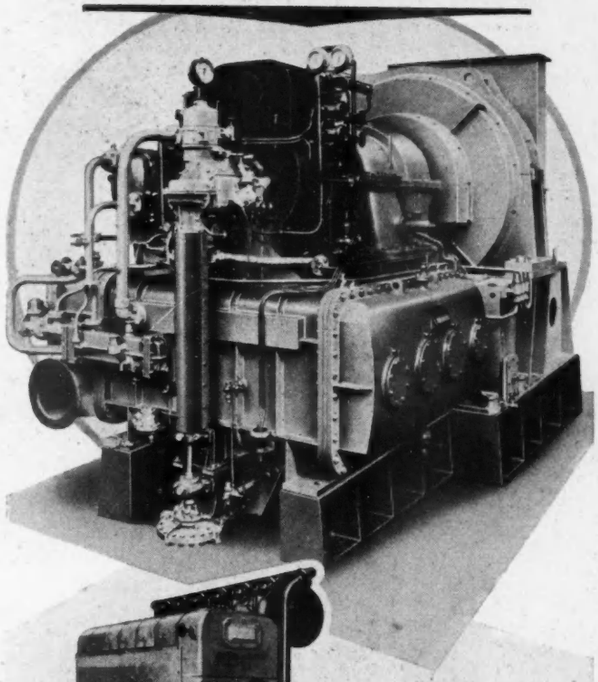

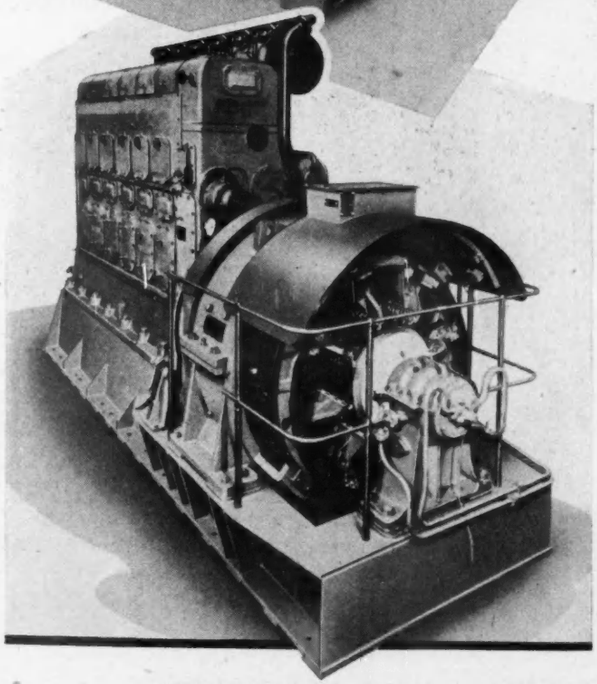

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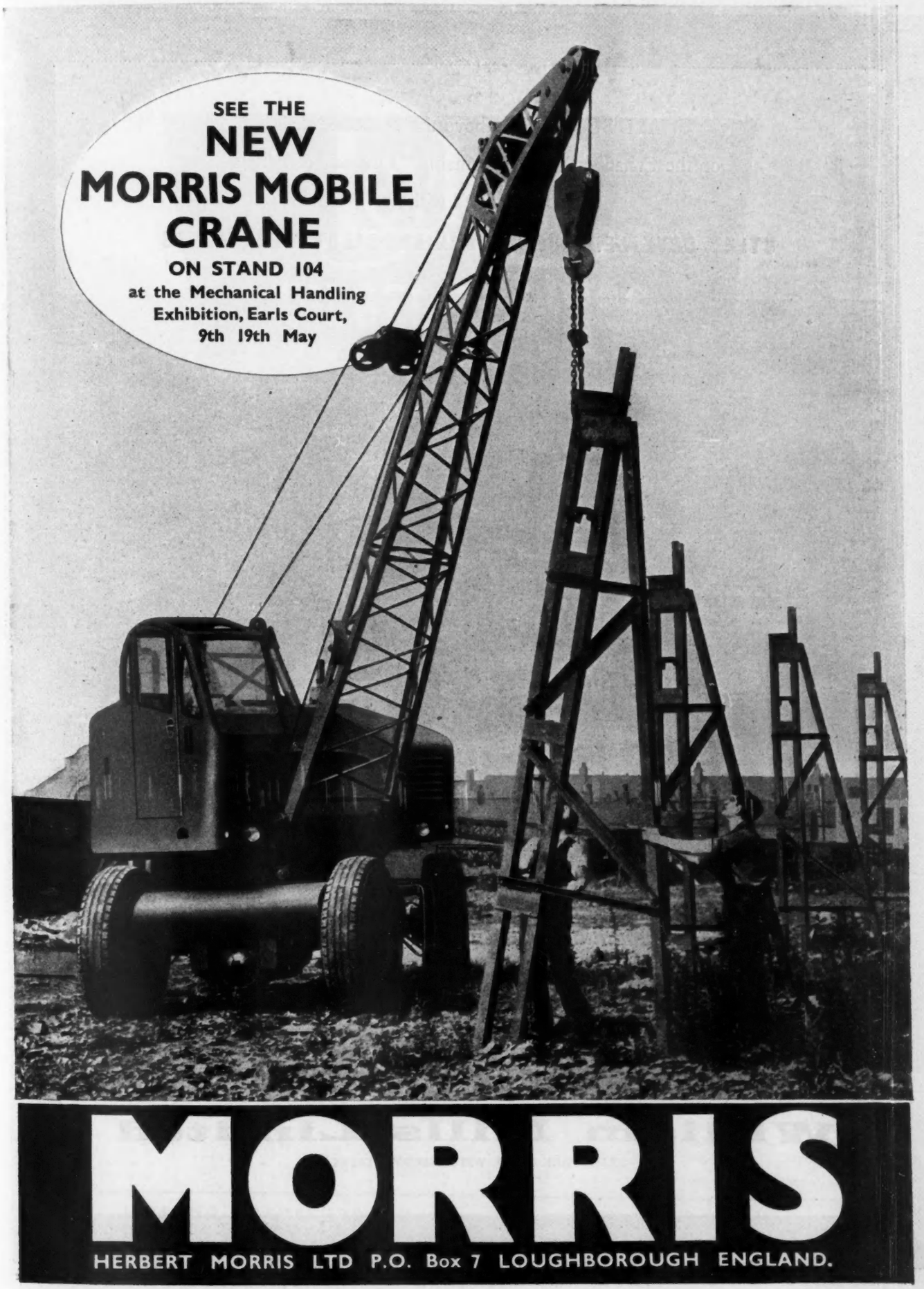
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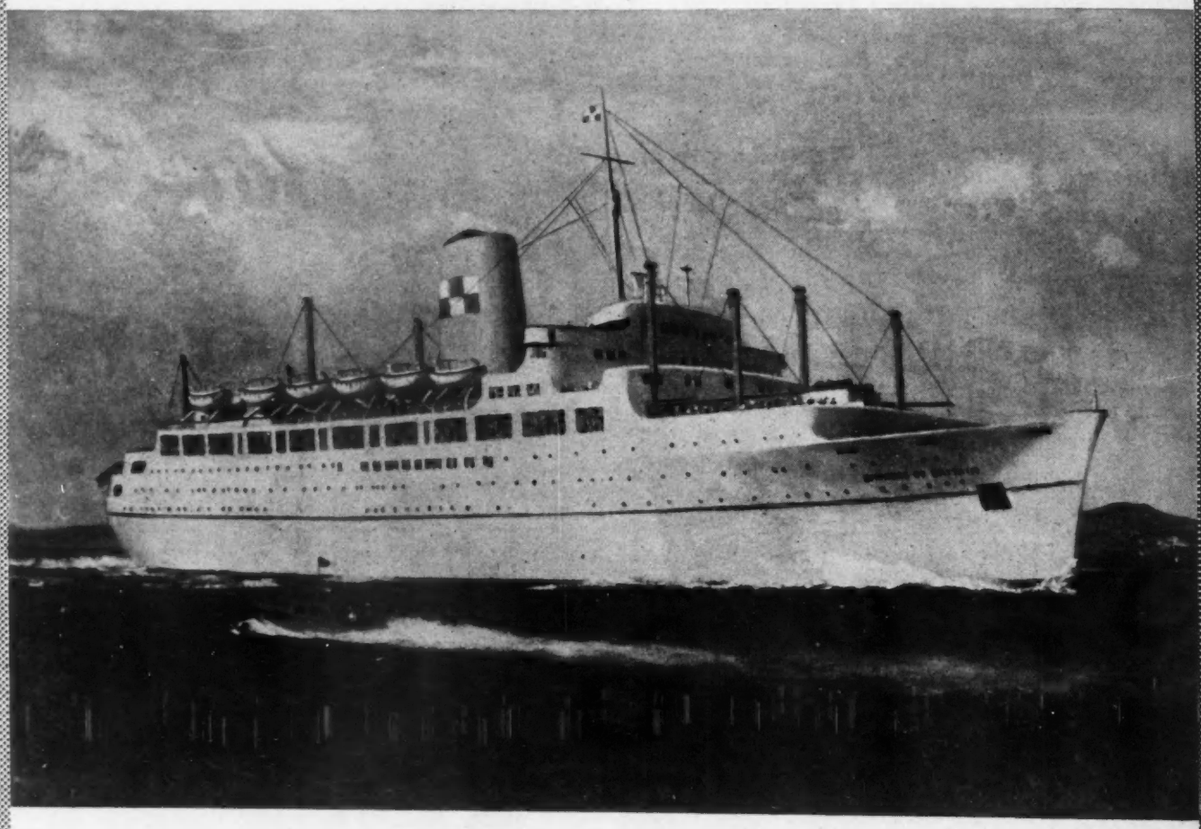

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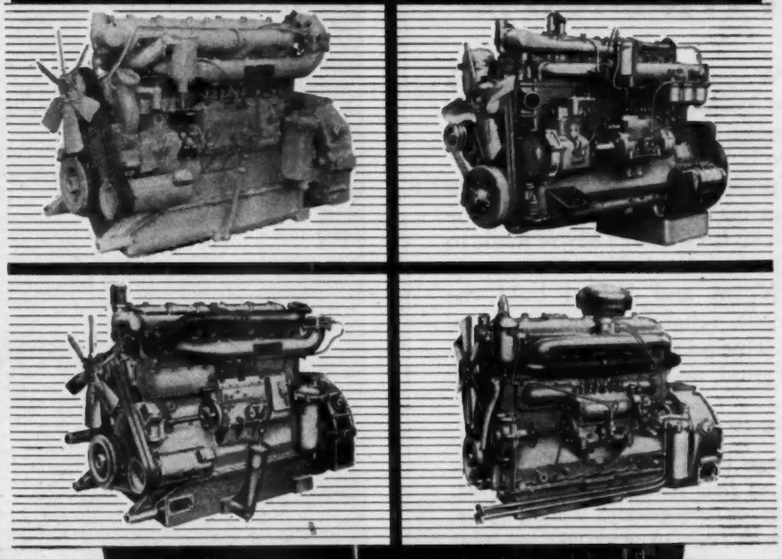

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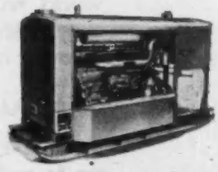

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600 Vertical or Horizontal	4.8 in. (121.92 mm.)	5.5 in. (139.7 mm.)	597 cu. in. (9.8 litres)	1,625 lb. (738 Kg.)	125 b.h.p. at 1,800 r.p.m.	112.5 b.h.p. at 1,800 r.p.m.	92 b.h.p. at 1,600 r.p.m.
680 Vertical or Horizontal	5 in. (127 mm.)	5.75 in. (146 mm.)	677 cu. in. (11.1 litres)	1,640 lb. (744.5 Kg.)	150 b.h.p. at 2,000 r.pm.	135 b.h.p. at 2,000 r.p.m.	115 b.h.p. at 1,800 r.p.m.
900 Vertical or Horizontal	5.5 in. (139.7 mm.	6.5 (165.1 mm.)	927 cu. in. (15.2 litres)	2,580 lb. (1170.2 Kg.)	200 b.h.p. at 1,840 r.p.m.	170 b.h.p. at 1,800 r.p.m.	142 b.h.p. at 1,600 r.p.m.

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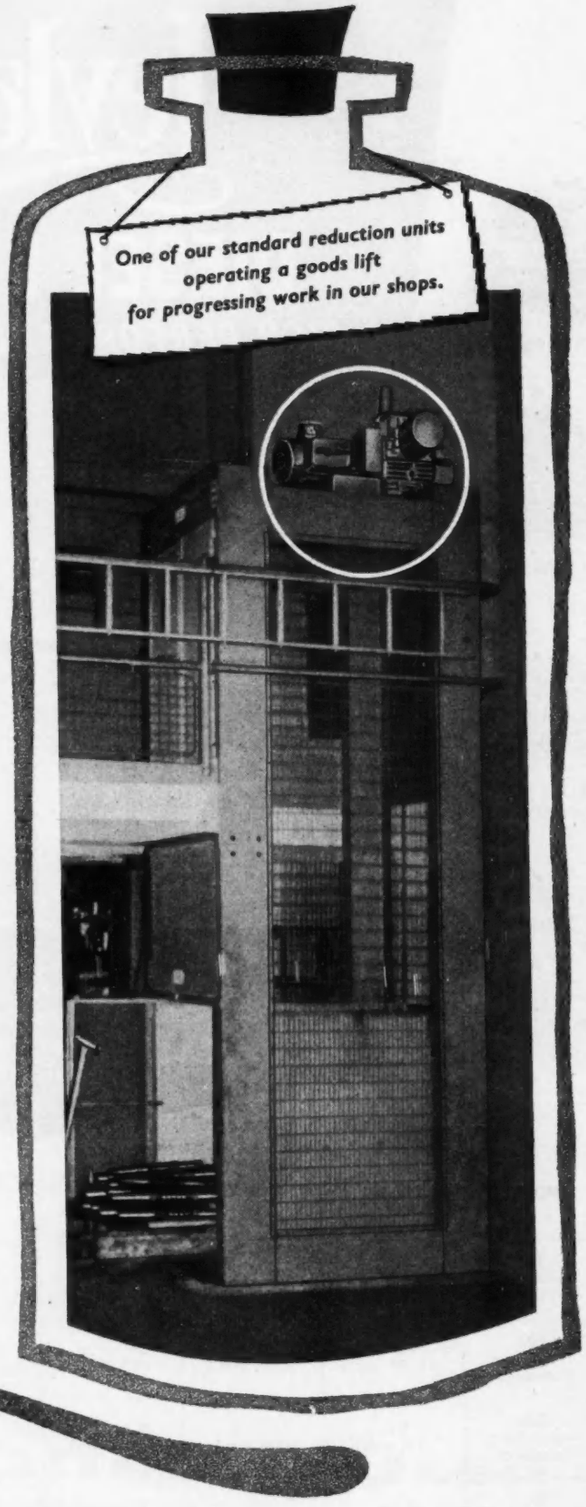

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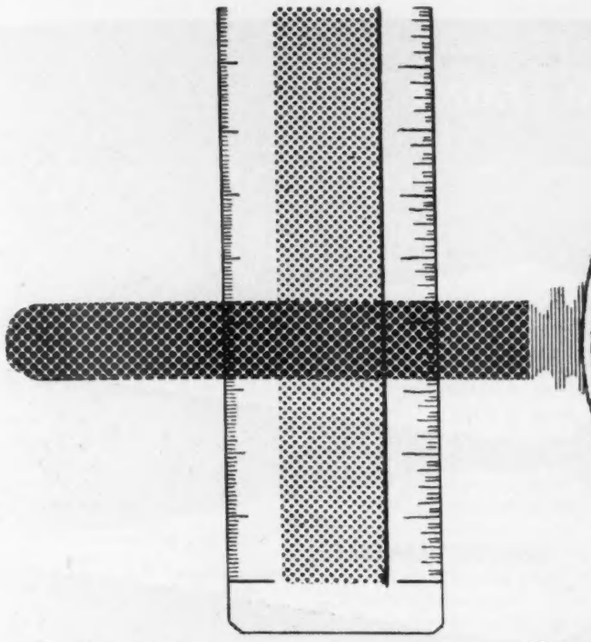

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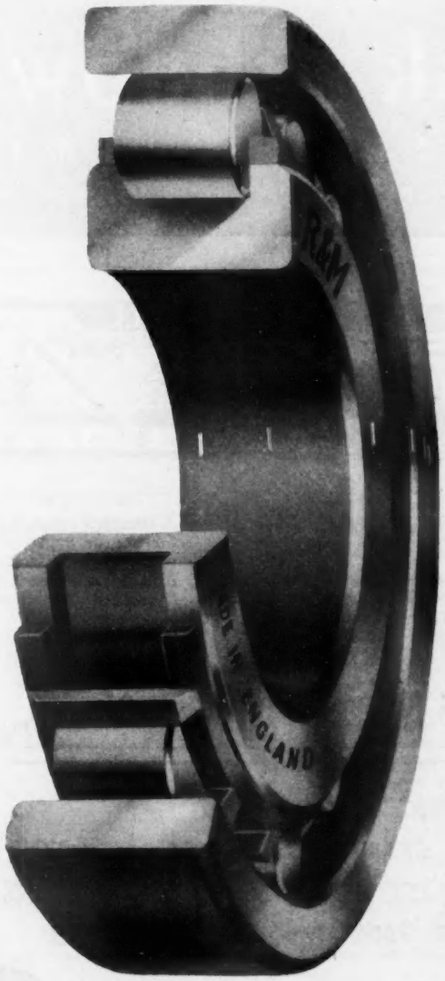

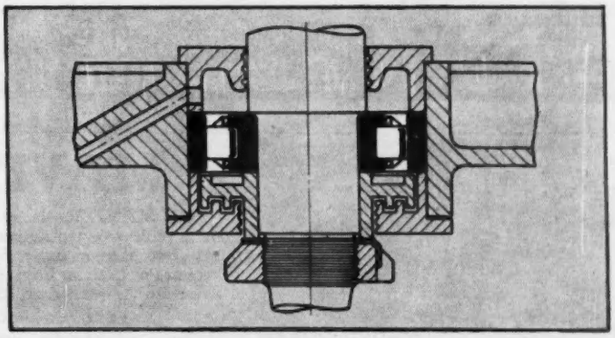

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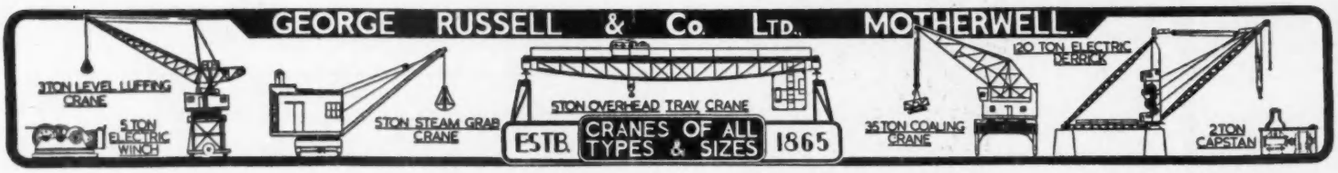
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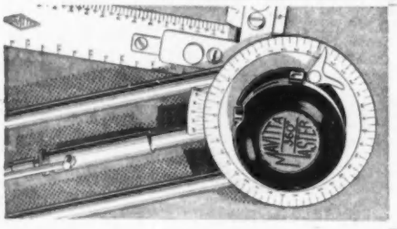

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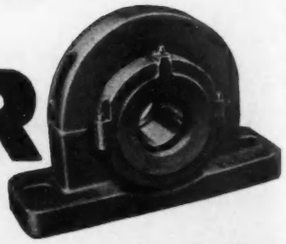

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ENGINEERING

An Illustrated Weekly Journal

Vol. 181 No. 4704 MAY 4, 1956

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SPECIALIST PROSPECT

As a sheet of metal takes new shape under the hammer of the coppersmith so is society modified by the blows of a new social force. A hundred years ago few could have predicted the changes which would be wrought by the growth of engineering science, and to-morrow's world, in spite of feverish speculation, is just as vague to us. However, in a special lecture to the Institution of Mechanical Engineers last Friday (see page 290), Sir Maurice Bowra made some thought-provoking observations on " The Impact of Engineering on Society," and by noting where the hammer strikes and the direction of the blow, we may judge to some extent the form that social development may take under this impact. To consider only a small part of that area covered by Sir Maurice, we may turn to his comments on specialisation.

" It is a false criticism," he remarked, " to say that specialisation narrows the intelligence. On the contrary it is usually when we are specialists in one thing, that we are able to look at other things outside our own sphere with fresh detachment and insight." Specialisation, as we know, is an inevitable feature of an advanced industrial society; it is a relief to discover that it is unlikely to narrow our vision, but may in fact give an added quality to our lives. This acceptance of specialisation has a considerable bearing on the way in which industry and even society may be administered in the future. We need no longer look on the specialist as a cloistered cenobite ignorant of the world and incapable of practical decisions, and may begin to call on him, no less than on retired soldiers and senior civil servants, to bring his broad understanding to bear on the highest administrative problems.

But if the engineer is to play his full part in society we have still many barriers and prejudices to break down. Thorstein Veblen, the American sociologist, observed that in an acquisitive or predatory society, wealth naturally commands respect, so that in course of time prestige comes to be associated with those pursuits which give evidence of " conspicuous leisure " and that there is consequently a " dishonour attaching to productive employment." The engineer has long suffered under this stigma of usefulness. Even at some of our universities to-day, the engineering undergraduate is looked upon by some as a thing apart, a dull fellow who may be able to row a bit but is ill-equipped to discuss the latest literary darling of Montparnasse.

Surely, from what Sir Maurice has said, the very trend towards specialisation will serve rather to stimulate the humanities than to stifle them. There is a tendency for " men who have a special, difficult job to think for themselves. However bad their original education may have been, once they master a special technique or a technology, they are almost forced to shape their own philosophy to it. They know it so well that they cannot help noticing at times that facts are not what they are commonly said to be, that there is more than one way of looking at a problem, that what may work as a passable truth in other professions does not work in theirs." Specialisation may therefore provide, too, a defence against mass communications, dictators and demagogues.

Specialisation is often looked upon as a limiting influence, but limitations are frequently very productive. Robert Stroud, imprisoned for murder in 1909 while still a semi-literate young man, became a recognised authority on ornithology to the extent of diagnosing bird diseases, performing dissections with sharpened finger nails and evolving a cure for the notorious " septic fever " to which cage birds are subject. He wrote *Digest of Bird Diseases*, which became a standard work on the subject. At sixty-five he is still in Alcatraz. Men often seem to flourish when restricted in some way or by some disability, and it may be that the growth of specialisation will have the effect of revealing man's deeper capacities.

There are certain dangers that accompany increasing specialisation. Not only is there sometimes a loss of contact between related studies, but progress in different fields gets out of step. Indeed, technology may get out of step with civilisation itself. The pressure of life has so intensified that we seldom have time to consider where we are going, what purpose other than survival our efforts serve. Now we are wondering what added strains will be placed on our economy by the need to compete commercially with countries where the interests of the individual can be sacrificed to the requirements of the State. Yet, however great the demands made on us, we should be unwise to abandon the diversity and independence that is the traditional feature of our society. Indeed, the scope for imagination which such a society offers may in the long run give us the advantage.

Whatever course events take, it is almost certain that society will become increasingly divided into specialist fields of activity, and that with the growing use of machines greater standards of skill, education and intelligence will be required of all sections of the community. As Sir Maurice remarked, " You cannot set a man to work a machine if he is unable to think within reasonable limits." What is more, it is technology that offers our greatest hope of preserving those traditions of humanism which we so much

value. Pure science, it has been suggested, excludes humanity by the very nature of its method, but technology impinges on mankind at many points; it is after all the means by which goods are made by men for men. It follows that though we must reconcile ourselves to an ever greater degree of specialisation—on this our survival may depend—we need not regret it; the specialised world of to-morrow may not in fact be an unhappy place.

* * *

Plain Words

To err is human, to forgive divine—so it is said. There appears to be a strong element of both these characteristics in the latest capital investment plans for the coal industry, published last week by the National Coal Board in a booklet "Investing in Coal." To those who may have their reservations about the applicability to the coal plan of the second half of the old saw, let it be said that the modern State's claims to divine omniscience are as importunate as they are impertinent.

In his statement accompanying the new plan, the chairman, Mr. James Bowman, said: "'Plan for Coal' was prepared after only two or three years' experience of the industry in the post-war world. The Revised Plan is based on much more solid knowledge and experience than was available in 1949. I think it is a more reliable and realistic document than 'Plan for Coal'." Let us hope so. The industry has been reported upon, commented upon, and the Fleck Committee has come and gone. The heads have rolled (in a decent, muffled sort of way) and it is devoutly to be hoped that out of it will come more coal more efficiently.

Basically, all this planning and setting of targets for capital expenditure, output and manpower is the intellectual and emotional process by which the country adjusts itself to the idea of dear coal. It is the apparently unquestioning way that the coal industry's blank cheque is signed which is so baffling. Over the years 1947 to 1955, the N.C.B. spent £422 million on capital development. In the next ten years it expects to spend £1,000 million, an average of £100 million a year. Over the whole period of 1947 to 1965, that is 19 years, it will therefore have spent £1,422 million. The announcement that the industry has applied to Parliament to borrow up to an additional £400 million comes at a time when deflation, as a conscious policy, is in the air. Coal is obviously going to get the money no matter what else goes without. Why should this be so? The urgent need to increase output to 240 million tons a year by 1965 is not the whole of the answer. Coal has had priority for 20 years. The railways had to wait until 1954 to get their 15-year programme of £1,200 million approved, and they have already had to take a cut of £12 million. The roads are likely to have to wait indefinitely.

There is something radically wrong. It is this. Long-term, grandiose plans for industries which are not subject to the discipline of the profit and loss account, and whose price policy (for "price policy" is in this context the substitute for "market") can be bedevilled by Government policy, are bound to suffer major alterations every so many years. Successive Governments have pursued a "cheap coal" policy and they now have to pay it back at an awkward time.

The railways, who have had to cope with a "cheap transport" policy, have thus nothing much to fear. They will get their capital investment programmes through despite their operating losses, so why worry about charges and fares? Such a method of planning the basic services may appeal to some people, but as the Welshman said on another occasion of great confusion, it's no way to run a railway. It's no way to produce coal either.

IMPACT OF ENGINEERING ON SOCIETY

It is notorious that the onlooker sees most of the game, and nothing could be more salutary for the players than that from time to time a discerning spectator should comment on their play. Last Friday at the Institution of Mechanical Engineers, members of the engineering profession were stimulated and entertained by the illuminating remarks of a most distinguished outsider, whose observations on their calling gave it a significance that engineers themselves have perhaps tended to overlook. Presenting the Second Graham Clark Lecture before a joint meeting of the three senior engineering institutions, Sir Maurice Bowra, F.B.A., M.A., spoke on "The Impact of Engineering on Society." We reprint here a slightly abridged version of the lecture, in which Sir Maurice set technical progress in its historical perspective. We have also added the illustration of Pekin man.*

Man, says Beaumarchais, differs from the beasts only in drinking without being thirsty and in making love all the year round. However important these differences may be, I would claim that man differs from the beasts mainly in being able to turn nature to his own use. Of course some animals can do this, but only on a very small scale. The pride of man is that he has already done so on a large scale, and seems likely to do so on a still larger one. By the construction of inanimate objects, which we call machines, we have extended on an incalculable scale what we are able to do. The process began a very long time ago, but it has on the whole been slow until quite recently, and it has by no means been regular. At the very start are the unknown inventors, who made discoveries which indeed showed what the control of natural forces may mean. If, as is possible, Pekin man, *Pithecanthropus Pekinensis*, really knew how to make fire, it is possible that he should be regarded as our forerunner, since without his discovery nothing would have happened. If he was closer in his structure to the apes than to *homo sapiens*, our debt to the beasts is greater than we usually admit and there is much to be said after all for having our ancestors not in Paradise but in the Zoological Gardens. If Pekin man does not quite qualify to be the patron saint of engineers, he should perhaps be remembered on their Founder's Day and have a place in their Golden Book of Benefactors.

CIVILISATION AND SURVIVAL

Now almost every society of which we know anything practises engineering to some degree. Even the Australian aborigines invented the boomerang, which was an ingenious and amusing means of hitting your enemies. But it is only in the last hundred or so years that society has really become mechanised on a large scale. The difference between ourselves and the ancient Egyptians is not that we admit the existence of engineering and they did not, for after all the construction of the Pyramids was an extraordinary achievement, but that they did not see the range of its possibilities. A considerable degree of civilisation can be secured with a minimum of engineering and, though we must certainly admit that without engineering civilisation is impossible, it is not always of first importance. In the eighteenth century China under the great Manchu Emperors not only appealed to the philosophers of the west as a model of good government and social graces, but can be seen to-day to have shown a remarkable capacity for organising an enormous area into law and order and for producing, at least in a limited class, a high degree of intelligence, sensibility and creative endeavour. But, though they led the world in the invention of printing, the mariner's compass and gunpowder, the Chinese evolved a civilisation in which engineering had almost no place. Even their buildings, though graceful and charming, were modelled on tents. Eventually their failure to recognise the importance even of those clocks and fountains which Jesuit missionaries had made for their emperors cost them dearly, when a mechanised Europe attacked and imposed its will on them.

An even more notable example of this neglect can be seen in the Greco-Roman world. In spite of promising beginnings—Archimedes' work on hydrostatics and engines of war and Roman competence in building bear witness to an engineering tradition—Greeks and Romans went no further, and like the Chinese paid a heavy price. Had the Romans of the later empire found another Archimedes to build military machines they would have had no more difficulty in disposing of Attila and Alaric than Kitchener had in disposing of the Khalifa. The trouble with a society which does not believe in engineering or see its possibilities is not that it cannot be civilised, but that it is not likely to survive. Civilisation is a sensitive plant, and its first duty is to look after itself.

A SORDID SUBJECT

This failure of two great systems deserves a moment's notice. Why did neither China nor the classical world exploit the possibilities of engineering? The cause cannot be ascribed to religion; neither Confucius nor the Olympian Pantheon were oposed to the mechanical sciences. Hephaestus, after all, was surely an engineer in the modern sense when he made mechanical beings to work for him in his arms factory. The explanation must lie elsewhere, and perhaps there is an illuminating hint in what Plutarch says of Archimedes and his more practical inventions.

> "Though these inventions had obtained for him the renown of more than human sagacity, he yet would not deign to leave behind him any written work on such subjects but, regarding as ignoble and sordid the business of mechanics and every sort of art which is directed to use and profit, he placed his whole ambition in those speculations the beauty and subtlety of which is untainted by any admixture of the common needs of life."

The engineer was somehow thought to be sordid and engaged on tasks below the dignity of a civilised man. We might, of course, say that you must expect this to happen when education is almost entirely based on the study of literature, and I must admit with regret that too exclusive a study of words may well breed illusions of grandeur about their pre-eminence and blind their devotees to other matters of first importance. But this was hardly true of Archimedes who had behind him some three hundred years of mathematical and even scientific thinking, based on experiment and precise observation.

CHEAP LABOUR

The contempt for applied mechanics displayed by Archimedes was rather a product of a society in which there was no shortage of cheap human labour. The existence of an inexhaustible labour pool meant that it never occurred to the educated and governing classes that this was not the best way of doing what was to be done, and still less that it could not do all that was possible to men. They assumed that this was the unchanging pattern of life and did not look beyond it. If inventions were to come it would not be from those who had the power to see that they were used; and if some more far-sighted man saw their possibilities, he would probably find nobody to listen to him. Such a man lived at the end of the fourth century A.D. and revealed the position in his tract *On Things of War*.

> "It is universally agreed that in the technical arts (among which we include the invention of weapons) progress is due not

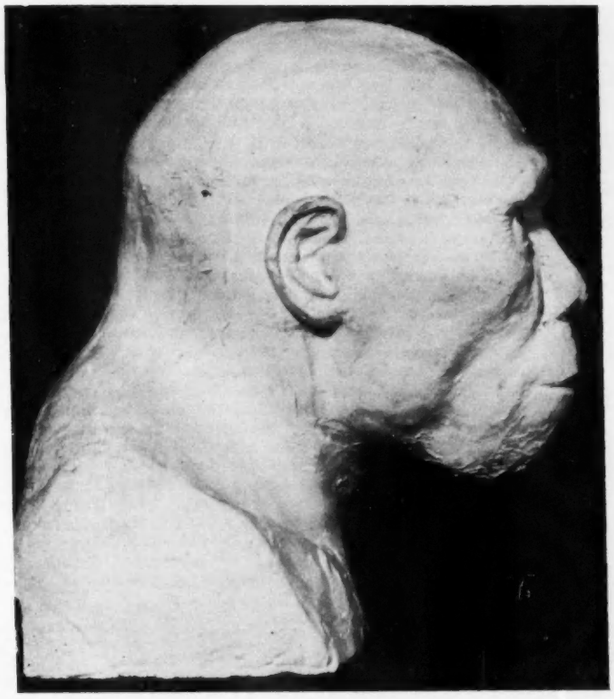
* Warden of Wadham College, Oxford.

those of highest birth or immense wealth ... public office or eloquence derived from ... rary studies but solely to men of intel- ... ual power (which is the mother of every ... cellence), depending as it does on a happy ... dent of nature."

The Romans, like the Chinese, rejected machines in the last resort because their ruling classes were snobs.

This is a social fact of first importance, and it is not irrelevant to modern times. The prodigious growth of engineering since the end of the Eighteenth Century has indeed been rendered possible by epoch-making inventions like the internal-combustion engine, but this itself would never have happened, or at least never have been turned to general use, if there had not been a complete change towards the part played by engineers in society. The old snobbish position had been so complacent that it was not so much hostile to engineering as completely oblivious of it. What was needed was something to break this complacency and suggest that after all engineering might do good even to those who thought they needed it least. This change was mainly due to the vast revolution worked by the dramatic appearance and rapid growth of natural philosophy. Just as the first Greek scientists moved without difficulty from inquiring about the nature of Being into inquiring about the nature of Becoming, and thereby opened the door to all kinds of physical speculation, so the natural philosophers of the Seventeenth Century saw that it was impossible to separate the nature of things from their appearances, and conducted experiments to see how things work as they do.

Economic forces undoubtedly played an important part. They began to undermine the old social order and to create opportunities for many who had hitherto been forced to be content with a humble station. Once it was clear that it was both profitable and honourable to know about mechanics, mechanics began again to produce its own men of genius.



Pekin Man: the patron saint of engineers?

GROWTH WITHOUT REVOLUTION

It is important to note that this vast change has not been revolutionary in the political sense. It has indeed changed the whole appearance of society and done much to change its structure, but it has not been aided by political revolution or had much to do with it. In no revolution, French, Russian or Chinese did applied science play a leading part or contribute anything to the revolutionary ideology. Indeed, we may suspect that if these three countries had been more mechanised, revolution might not have come at all or have taken a less virulent form. These people saw violence as the only solution to their troubles, but engineering tends to suggest that there is a cure for most evils, and that the age-old troubles of man such as starvation, disease, floods, and the like can be surmounted by a proper use of machines. It is indeed significant that the classic case of growth without revolution should be in a country which has used engineering on the greatest possible scale. The United States, which was brought to birth by revolt, has, despite the inevitable disorders of its first expansion and the catastrophe of the Civil War, never come near to social revolution and seems determined at all costs to avoid it. This is all the more remarkable when we consider how many immigrants in the nineteenth century arrived with advanced radical opinions and how sharp the social conflict was in the period of the great millionaires after the Civil War. Here, we might think, was an ideal powder-barrel, ready to blow up at the first application of a match. But it has not. Though the United States owes more than any other country to the practical application of mechanics, and has won its successes with a good deal of strain and trouble, it has remained remarkably faithful to its fundamental assumptions of what American life ought to be.

Engineering is not a political activity but aims at something quite different—the control and exploitation of natural resources to give a greater degree of human welfare and embodies the outlook that man's struggle for existence can be made progressively less laborious as his knowledge of these processes increases. It is all very well to look back with regret to the age of the Antonines or of Louis XIV or even of George III, but I am very suspicious of this particular brand of intellectual opium.

A STABILISING INFLUENCE

The work of the engineer is a stabilising influence. On the one hand it avoids the angry discontent which is inevitable when no change seems possible, and on the other the complacency which assumes that everything is after all as good as it can be and that nothing need be done about it. It moves in an ordered process in which every new step is a real advance and leads to others beyond it and as such satisfies both man's desire for order and stability and his love of novelty. Society thus develops a rational approach to its problems and stability becomes something almost beyond price.

This aspect of engineering is extremely relevant to the modern world and has been assiduously employed by the governing classes of revolutionary states to maintain their power. In this case Stalin's practical wisdom cannot be doubted; and in Russia and China engineering was seen as the way to reconcile the immense demand for an improved way of living with the imposition of a strict discipline.

If we could believe in progress with the happy optimism of the nineteenth century, we might well think that the increasing command of mechanics would inevitably lead to the greater happiness of mankind. In principle there is no reason why it should not, but our own age has issued too many warnings against vaulting hopes for us to be able to believe it. It has learnt to its cost that mechanical progress can too easily be defeated by political insanity and that just because engineers are confined to their own social and national systems, they can do little or nothing to prevent it. Both international war and class-war have dominated and damaged our lives despite the obvious increase in most countries of prosperity and ease. For this we must blame man in his capacity of a political animal. He has failed to evolve means by which his desire for security and prosperity can be combined with other darker and less rational forces in his nature.

In a fair judgment, if the engineers are to blame at all, it is for sins of omission rather than of commission. I would not deny that they have created weapons of destruction such as our ancestors never dreamed of, but at least it can be said on their behalf that in this they were only the servants of political power, that it was not their own ambition to fashion instruments which might blow up the world.

The blame for this lies with the mass of men who insist on destroying each other. Where the engineers have gone wrong is perhaps in taking too modest a view of their own task and their own duties. They have set out in all sincerity and decency to improve the human lot, but this, unfortunately, is not always what humanity asks for. When, for instance, we look back to 1914 and see how prosperous Germany was, how rapid were her advances in all branches of applied science, how doctors of engineering from the Technische Hochschule at Charlottenburg seemed to have before them the whole wide world from the Rhine to the Yangtse, we must surely be amazed that the Germans insisted upon going to war. Not only in Germany but in Britain, too, young men like Rupert Brooke went gaily to their dooms believing that this was an escape from a life in which their best impulses were stifled by comfort and security. The mass of men accepts the contribution of engineers for a while and then, in wild frenzies of unreason, rejects it and destroys it.

IN PLACE OF WAR

For this I can see no cure. It is not easy to find an emotional equivalent to war for those who like war, or at least like to send others to it. But if what is wanted is excitement, if what some men resent in ordered society is that it is too dull, there can be no doubt that engineering can offer them thrills in plenty. The conquest of the air, which we now take almost for granted, has provided not only problems to be solved at the highest intellectual level but the practical application of their solutions with a confidence which is the modern equivalent of heroic courage. The conquest of famine and drought by the proper control of water supplies calls for generalship at the top and consummate discipline and skill among the other ranks. The exploitation of new sources of power calls both for strategy and for tactics in many unfamiliar corners of the globe and evokes visions of advances over enormous fronts. Engineering, more perhaps than any other branch of human activity, provides an imaginative equivalent to war, and has the advantage that it creates instead of destroying. Whether mankind will learn this in time is perhaps too much to ask. But let us at least indulge in a faint hope that it will.

To be bored to such a degree is surely a terrible failure in oneself. But there are more subtle and more specious criticisms than this against the growing part which engineering plays in the world. Nobody who is interested in human beings can fail to take pleasure in their enchanting variety, not merely in their individual differences but in their differences of customs and thought and circumstances; through our great humanistic tradition we judge civilisa-

tion by its ability to sustain the widest variety possible. Anyone who holds that freedom expresses itself in variety and that variety is a test of the richness of life must surely be a little alarmed by the formidable drive towards uniformity in our time. Russia spares no pains to turn its curiously assorted victims into a respectable imitation of the bourgeoisie, knowing that this will make easier and safer the business of government; while the desire for conformity in the United States is no less powerful, where it stems from a need to feel at home and have a life in common, free from anomalies and eccentricities. And, though the drive towards uniformity is undoubtedly political in origin, it has no less undeniably found a powerful ally—particularly in its revolutionary effect on communications—in engineering.

UNIFORMITY AND VARIETY

The revolution in communications has meant a vast change in traditional ways of life by the introduction of standard, international objects of every kind, and though this process of "Westernisation" is probably more superficial than we think, Western *cuisine*, comforts and opportunities for hygiene do in fact spread along all the main lines of communication.

However, since we cannot expect any material civilisation to remain static, Western gadgets installed in Bokhara may one day have the charm of Portuguese Baroque churches in Goa and Macao, and archaeologists be as delighted to find the remains of gramophones and sewing machines in Ulan-Bator as their present counterparts are to find Roman coins in Travancore. Nor need we deplore the way in which most languages absorb words from other countries; linguistic oddities like ἀμανέξ and αἰλαῖφ do not detract from the charm of a language, whereas when the Germans insist on calling the telephone "*Fernsprechen*" they show an unbecoming nationalism, and an ignorance of the laws of that philology to which they have given such patient and misguided toil.

THE TYRANNY OF TIMIDITY

A more serious charge against the influence of engineering is that it interferes with the variety of the individual self by imposing on it certain patterns through Press, cinema, wireless and television. It is perhaps not enough to say that we need not listen to them unless we wish, for sometimes we are in a mood to listen to anything—and then the deadly work begins. The danger is great when these organs are controlled by a single authority, but hardly less dangerous when an exaggerated respect for the views of misguided but touchy minorities forbids the public expression of anything which might cause them pain. Truth flourishes on controversy and when the B.B.C. seeks to avoid it or to reduce opposite points of view to a woolly muddle, it betrays its heritage and shirks its chief duty.

But this new system of imparting information is still in its infancy. It may of course become an ever more stifling influence and we should beware of this. However, before long, it will perhaps be possible for any one in any part of the world to hear programmes from every other part in spite of powerful efforts to stop them—which will probably be no more successful than efforts in our own time to stop people listening to programmes from London or Berlin or Athens. As programmes multiply the innate curiosity and perversity of men will lead them to pay attention to much which is not supposed to concern them and the tendency towards uniformity will become less and less apparent.

SPECIALISATION AND IMAGINATION

Another source of hope, if not quite of confidence, may be found in the undeniable tendency of men who have a special, difficult job to think for themselves. It is a false criticism to say that specialisation narrows the intelligence. On the contrary it usually happens when we are specialists in one thing, that we are able to look at other things outside our own sphere with a fresh detachment and insight. So in the end it looks as if engineering, which has undoubtedly played into the hands of some of our new bosses by providing them with instruments for shaping thoughts, will change its direction and make it easier for thoughts to be free.

A final objection raised to engineering in social life is that it imposes a standard of culture which lacks the variety and the beauty of the old craftsmanship, that it substitutes the dead products of machines for the fine work of men's hands, that it destroys the grace of life even in the small, select circles, where it is still cultivated. Now it is perfectly true that most machine-made articles have not the charm and the distinction of Chippendale or Wedgwood, that concrete lacks the variety of stone, that mass production may destroy the old delight of the eyes in things made by hands. It may well be the case that increased production will spoil some of the old fine art of workmanship. But we should not allow this to get out of proportion or wrong conclusions to be drawn from it.

Some historians maintain that civilisation becomes degraded as soon as the cultivated tastes of a few are shared by many. It has even been claimed that this was one of the main factors in the decline of the Roman Empire. This certainly is not true. In the Roman Empire one of the chief causes of decline was the ever-increasing gap between the rich and the poor, and the consequential limitation of arts and sciences to a very small class. Nor is the theory true of modern times. The countries which have shown the greatest intellectual and social advances, France, Great Britain, and the United States, have all managed to extend their refinements to an ever-increasing class. Of course such a process will show its growing pains. Of course there will inevitably be failures of taste. Nevertheless, triumphant works of architecture show how engineering has called into being new standards of taste; indeed, it is the failure to understand the use of engineering and modern materials that has given rise to the proliferation of "Banker's Georgian" and "Rothschild's Second Empire." There is no real reason why a world which relies on machines more than on handicrafts should not in the end produce objects as satisfying as those of the old craftsmen. It is the actual objects not the method of multiplying them that counts. They will be in more generous supply. They will not be unique treasures. But they will give delight to a far greater number of people than the old system of privileged elegance could ever do, and in the end man's natural desire to do things well will triumph, and a new kind of grace and charm will emerge.

MAN'S UNIQUE POSITION

As the Greeks said "even the gods do not fight against necessity," and for us engineering has become a necessity. It is madness to fight against it, to wish that it had never been. It has brought untold benefits to the world, and if it has often enough been held responsible for our catastrophes, it is we, and not it, who are to blame. I even cherish the hope that it may help to solve some of our political troubles. In so far as it offers by far the surest and safest way to improve the human lot, is it perhaps not too much to hope that in the end the majority of mankind will see that it is far saner to alter social conditions by its controlled and rapid methods than to revert to violence, which always means that an unforeseen situation is created and that too much has to be done all over again? Man's unique position in the scheme of things lies in his ability to turn nature to his own ends, and if he really knows what these ends are, he should be able to do on an ever-extended scale what he has already begun to do with such imagination and devotion and skill.

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Letters to the Editor

WATER RESEARCH ASSOCIATION

SIR, May I draw attention to a statement on page 230, April 20: "The Water Research Association is the latest of the . . . research associations which receive financial support from the Department of Scientific and Industrial Research."

The Water Research Association is not a grant-aided body, and while most readily recognising the valuable help it has received, I must make it clear that the Water Research Association receives as yet no financial support from D.S.I.R.

Yours faithfully,
J. L. ROBINSON,
Information Division.
The Water Research Association,
Redhill, Surrey.

* * *

PATENTS BOUGHT AND SUPPRESSED

SIR, I was surprised to see in the "Plain Words" column of your issue for April 20 a repetition of the old canard that there are "really restrictive practices such as the acquisition of patents to suppress a new product" which are not adequately dealt with by Statute.

The wicked habit of suppressing inventions is often referred to by street corner speakers but a responsible journal such as ENGINEERING should know that the charge has never been substantiated. In particular, the Swan Committee, whose findings were used as the basis for the Patents Act 1949, found no evidence whatever to justify the kind of statement you have now made. From some years' experience of industrial patent matters I can support their conclusions.

For professional reasons I must sign myself,
"CHARTERED PATENT AGENT."
April 30, 1956.

* * *

COMPLETION OF STEEL FURNACE RE-BUILDING PROGRAMME

Templeborough Melting Shop, Rotherham

The fourteenth and final open-hearth furnace in the quarter-mile long Templeborough melting shop of Steel, Peech and Tozer, a branch of the United Steel Companies Ltd., Sheffield, has been entirely rebuilt and enlarged from 80 to 100 tons capacity and is now in production. This ends a major reconstruction programme which began early in 1953. The production of steel at the Templeborough shop amounted to 594,027 ingot tons in 1952, the last full year before the reconstruction work commenced, it rose to 729,171 tons in 1955 and is expected to reach 800,000 tons this year.

The average time taken to reconstruct each furnace, from tapping the last melt to relighting, was about nine weeks. Altogether 3,000 tons of steel and nearly 10 million refractory bricks were used in the conversion programme. The enlarged furnace hearths are 25 in. thick and each furnace, which has a basic lining, has a bath capacity of 484 sq. ft. Nine of the furnaces are oil fired, four are fired with creosote pitch and the remaining one is maintained on producer gas for experimental purposes. Fuel oil, however, can be used as an alternative to creosote pitch in the four furnaces concerned, according to fuel availability. Twelve furnaces are in operation at any one time, the remaining two being down for routine repairs and re-lining.

On account of the increased volume of steel and slag to be handled from the 100 ton capacity furnaces, it was necessary to replace the four existing 100 ton ladle cranes in the casting bay by 150 ton cranes. This, in turn, called for a complete renewal of the crane-track girders. As the furnace conversions proceeded, the new cranes were erected in succession and the old ones dismantled, the programme being arranged to ensure that the growing furnace capacity was always matched by the requisite crane-handling capacity.

Weekly Survey

Cover Picture: *The photograph shows the armature of a rotary converter—a synchronous machine for converting alternating current to direct current or vice versa. The insulated risers are being soldered to the common armature windings at the correct intervals round the periphery.*

★ ★ ★

Giants of Engineering

Among the 100 largest companies in the United Kingdom, 31 are metals and engineering concerns, in 1954-55 representing 29 per cent. of the 100's total net assets and 33 per cent. of their income. These companies, whose list is headed by Vickers, have total assets of £1,245·8 million and an income of £273 million. This information is contained in a pamphlet published by the National Institute of Economic and Social Research, *A Classified List of Large Companies Engaged in British Industry*.

The classification throws a new light on the relative size of the giant engineering concerns and on the relationship between capital resources and income. The asset ranking by no means corresponds to the income ranking, and the differences—which tend to be more between industries than between companies—suggest that the productivity of capital is much less say, in iron and steel, shipbuilding, or non-ferrous metals, than in motor vehicles, aircraft or electrical engineering. Unfortunately the classification does not take into account the profitability of each enterprise and it may well be that such an analysis would show that profits do not follow the same pattern. It is none the less of considerable interest.

The 31 metals and engineering companies among the 100 giants include 12 concerns making mainly iron and steel, 5 making electrical machinery and household appliances, 4 making motor vehicles or accessories (Joseph Lucas is included), 2 shipbuilders and 2 aircraft manufacturers. A characteristic of most of the engineering companies in the list is the wide range of products they make: Vickers, who head the list, make aircraft, ships, office machines, printing machines, cement plant, and a host of other products. The same is true of the five major electrical engineering concerns. One of them, English Electric, make aircraft, rolling stock, radio and television apparatus, instruments, turbo-generators, transformers, electric motors, Diesel engines, etc. Ford (who have the largest income of any engineering group) make iron and steel, cars, commercial vehicles, agricultural tractors and a wide range of components. The only companies within the engineering grouping among the top 100 concerns who do not have a widely diversified range of products are Swan Hunter and De Havilland.

This document will repay detailed study by anyone who makes it his business to guide the investment policy of a manufacturing company. He will doubtless come to the conclusion that to make mass-produced goods—and this means consumer goods, or components for them—requires far less investment than to make capital equipment and heavy machinery. It also requires less labour and less skilled engineers. It is also a better field for the introduction of automatic processes. He may therefore order a copy of the Sears Roebuck catalogue to look for a good product with mass appeal. Another conclusion he may draw from such a study is that if he is making capital plant, mechanical handling or instruments, it will pay him to diversify, not so much to spread his risk as to be in a position to offer a complete system of engineering. Harry Ferguson was the first to realise this and the first to cash in on the idea: he believed that farmers needed not merely tractors, or ploughs, or hoes, but a complete integrated system of implements and machines. The same idea applies to other industries and has been the basis of post-war growth in U.S. engineering. To engineer systems has become more important than to make the bits; to be in a position to do both is the key to success.

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Internationalisation of European Airlines?

Co-operation is a means to an end and the end must never be lost sight of. Like liberty, it has had many crimes committed in its name. It is with this clear distinction in mind—as between means and ends—that the proposal for joint operation of European airlines should be examined. The proposal came from a committee of experts meeting under the chairmanship of M. Spaak, the Belgian Foreign Minister. It recommends a scheme for the joint operation of European airlines, joint aircraft building programmes and, eventually, the fusion of European airlines.

Two entirely distinct ideas lie behind this proposal. On the one hand there is the possibility that the international airline operators might standardise on their specifications and that military operators might do the same. There is a great deal to be said for co-operation of this kind, and of course some progress has already been made in that direction. The second idea springs from the concept of economic integration of Europe. There may be much that is desirable in the urge towards unifying Europe, economically as well as politically, and it may be accepted that certain kinds of intra-national competition should be avoided. But such thinking should not lead to an uncritical acceptance of international monopolies.

Europe will not survive as an economic unit if commercial competition is stifled in the interests of political unification. It would be fatal to allow the idea to become accepted that because Europe should become united, one of the means of achieving this would be by creating monolithic commercial organisations whose size and functions were governed by a definition of the word "European," rather than by the job which they exist to do—and that with a maximum of efficiency. Europe must prosper economically because of competition, not in spite of it.

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Colonial Development out of the "Red"

The fact that the Colonial Development Corporation made a net surplus of £409,000 in 1955 will be a source of satisfaction to all who have an interest in the prosperity of under-developed territories. The improved performance of the Corporation in the last few years under its new chairman, Lord Reith, is a triumph for patience and re-organisation. It is apparent from the statement by the Corporation last week that the immediate cause for concern is the rising rate of interest on loans from the United Kingdom Government. Long-term accommodation now costs 4¾ per cent., and this is a large burden on many projects which might be profitable on any reasonable, objective investigation, even if they are only marginally so.

In an address given before the Royal Society of Arts last month, Mr. H. Nutcombe Hume, the deputy chairman of the Corporation, dealt with the organisation and activities of the C.D.C. His final passages on the lessons which the Corporation has learnt from its past experiences are a complete vindication of those, both inside and outside it, who have argued for many years that the raising of the standard of living in under-developed territories is a matter for patience, good organisation and a careful study of the facts. In such areas, both the Government and private enterprise alike must make haste slowly.

Mr. Hume emphasised the need for a cautious and realistic approach. He paid tribute to the commercial discipline under which the Corporation is obliged to work. "Proposals for immediate large-scale development," he said, "must be looked at with much scepticism. There must often be several years of patient experimentation and trial before it can be known that a given crop or a mineral can be produced on a worthwhile scale. All this means delay and is also expensive; so there must be some certainty that the ultimate return will be such as to justify the cost of experiment and development; there must be a detailed research into markets and the closest possible forecast of prices." Such words, together with the emphasis which is placed on the need for good management on the spot, bespeaks the experience of a man and an organisation which has learned, as most of us do, the hard way.

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Investment Policy for 1956

Aagainst a background of a decline in the industrial index of production (the provisional estimate for March is between 140 and 141 compared with 143 in March, 1955) and a Budget which leaves with the Government the maximum flexibility for pursuing a policy either of inflation or deflation, the Budget debate has given the first hint of the Government's investment policy in the new fiscal year. Sir Edward Boyle, Economic Secretary to the Treasury, looked forward in the debate to "a very considerable increase in fixed investment."

The fact that investment was rising showed, in his view, that production would also increase. How smoothly this occurred would depend on the success achieved in redeploying resources from home to export markets. Mr. Harold Macmillan, in due course, ventured to say that the economic problem for the country was marginal, that is to say, a comparatively small effort might be sufficient to offset inflation if it were intense enough, and added that the public were overspending at the rate of 2*d*. in the £. It could therefore be a reasonable interpretation of the Government's point of view to say that, provided the public begins to save seriously and that this is accompanied by a switch of resources from home to export markets, the upward trend of industrial production can be quickly restored.

It would appear, therefore, that on balance the Government do not expect to have to persist much further with the policy of deflation. There may, of course, be a connection between the extra £100 million of investment which the economy is to take on and the proposed £100 million cut in Government expenditure. If this should be so, however, the likelihood of increased investment becomes tied to hypothetical cuts in Government outlay—cuts which are notoriously slow to achieve their target, to judge from past experience. There are plenty of candidates for the extra £100 million a year if it should be realised. Under the new coal plan, the coal industry alone proposes to raise its average annual rate of capital expenditure by nearly £50 million.

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Indian Steelworks

The target set by the Government of India for the production of ingots from their three widely-heralded steel plants, to be built during the next few years, is 3 million tons a year by 1961, each of the three plants being rated at 1 million ingot-tons a year. This output will be supplemented by an equal quantity to be produced by the Tata Iron and Steel Company, Limited, and the Indian Iron and Steel Company, Limited, and the magnitude of the effort to be made in achieving an annual production of 6 million tons during the next five years is seen in its true perspective when it is recalled that India's production of steel ingots in 1955 was in the neighbourhood of 1½ million tons only. In spite of the projected four-fold increase represented by the figure of 6 million tons, it is now considered in India that still further expansion will be needed to meet the demands of the country. It appears, therefore, that India will continue to import steel products from this and other industrial countries probably for many years to come.

Of the three Government-owned plants, one for flat products is to be built at Rourkela; in 1953 the German Krupp-Demag group under-

took to act as consultants for this plant. For the work of site development and the placing of orders, the Government has created the Hinhusthan Steel Company, Limited. The second plant, for the production of structural steel, is to be built at Bilhai and it is understood that the equipment will be supplied by the Soviet Union and that its erection will be undertaken by the Government of India with the assistance of Soviet engineers and technicians.

The third plant, a fully-integrated steelworks to cost about £80 million, is to be built at Durgapur in West Bengal by the Indian Steelworks Construction Company, Limited (ISCON) a consortium of some of the leading British engineering firms. Though the Government of India are to undertake the task of site development and the construction of the works for the Rourkela and Bilhai projects, they will be relieved of these responsibilities at Durgapur as the British consortium has undertaken to build and hand over the works ready for operation. The speed with which agreement between the Government of India and the Indian Steelworks Construction Company, Limited, has been reached is evidence of the mutual goodwill which has characterised the negotiations.

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British Contributions to Indian Steelworks

Brief technical particulars of the new Durgapur Steelworks, to be built by ISCON, have now been released. Interesting features are that the ore fed into the blast furnaces will have an iron content in the region of 55 per cent. and that the coke will be made in Simon-Carves coke ovens from a blend of Barakar and washed Jharia coals. A number of years ago when blast-furnace practice at the Jamshedpur Works of the Tata Iron and Steel Company, Limited, was being discussed at a meeting of the Iron and Steel Institute, it was pointed out that although a reasonably pure hematite ore, low in phosphorus, was utilised, yet the pig iron produced was basic because the coking coal—a blend from the same sources as mentioned above—contained a relatively high percentage of phosphorus. Reference was also made to the smallness and softness of the Indian coke, and the general position seems to be that whereas we, in this country, produce good pig iron from poor ores and, on the whole, good coke, Indian furnaces make a satisfactory pig iron from good ore and, in some respects, inferior coke.

The three blast furnaces of the plant will be built by Head Wrightson and Company, Limited, and will have 27 ft. hearth diameters and outputs of about 1,250 tons of iron a day each. They will thus be similar to those recently built, or under construction, in this country. The steelmaking plant is to be constructed by the Wellman Smith Owen Engineering Corporation Limited and will include two 800 ton inactive mixers, eight fixed 200 ton and one fixed 80 ton basic open-hearth furnaces. Evidently fixed rather than tilting furnaces are more suited to the local conditions. The rolling-mill and wheel, tyre and axle plant to be built by Davy and United Engineering Company, Limited, will have an annual production of 790,000 tons and will include a 42 in. blooming mill, a 32 in. intermediate mill and a 24 in. section mill. The 32 in. mill is to be manufactured by the Brightside Foundry and Engineering Company, Limited.

Other firms in the consortium will be responsible for the electrical machines, plant and equipment, for the fabrication of structural steel for the buildings, and for the civil engineering work on the site. According to the tentative construction programme, the first stage, comprising the first coke-oven battery of 78 ovens, a first blast furnace and part of the workshops, should be completed by June, 1959. The second stage, consisting of the second coke-oven battery, the second blast furnace and part of the steel plant and rolling mills, should be in operation by December, 1959, and the third stage, comprising the third coke-oven battery, the third blast furnace and the remainder of the workshops and steel and rolling-mill plant, by December, 1960. Finally, the wheel, tyre and axle plant should be ready in March, 1961.

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Road Bridges in Norway

The development of road bridges in Norway—particularly the influence of local conditions on the choice of materials—was reviewed in a paper presented to the Institution of Structural Engineers by Dr. Arnulf Arild on April 12. In the introduction the earlier types of bridges (stone arches, timber bridges and the first girder and suspension bridges) were briefly considered. The bridges built over the last 50 years were described in more detail, specially the flexible suspension type developed by the former chief engineer of the Norwegian Roads Administration, Mr. O. Stang.

Owing to wholesale destruction during the last war, a large number of bridges have been or are being re-built. Composite steel and concrete construction has been used in Norway, in order to economise in steel, since the early 1930's. But the application of welding in Norway has been more gradual than in other countries, due to the lower winter temperatures. Prestressing has only recently been introduced, but some interesting applications were described, for example, the bridge at Osterhus consisting of concrete girders with external prestressing cables. In a bridge at Kjevik, which incorporated composite construction, both permanent and temporary prestressing cables were used.

Notable major bridges are the Karmsund, which includes a latticed steel two-hinged arch of 603 ft. span, with concrete viaducts carried on columns reaching a maximum height of 130 ft. (a film showing the erection was shown), and the Varodd bridge which includes a central suspended span of 1,100 ft. (the largest span in Scandinavia). The latter is stiffened by lattice girders braced at the top and bottom chord levels for torsional rigidity since the unstiffened type of suspension bridge has proved unsatisfactory for large spans. The paper concluded with a survey of the Norwegian loading specifications since 1912 to the present day. In general, the present loadings are somewhat lighter than the British figures, the maximum permitted axle load being 13 tons.

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Full Employment for Shipbuilding

The shipbuilding industry's order book is at present large enough to keep the industry fully occupied for more than three years. At March 31 there were 2,261,000 gross tons of shipping under construction in British yards, compared with 2,144,000 at the same time in 1955. According to Lloyds shipbuilding returns for March, 1956, the volume of orders outstanding (that is ships for which plans have been approved or material ordered but which have not been started) increased by 281,000 tons from the end of December, to 1,719,000 tons at the end of March. This is the third successive quarterly increase recorded since the upward trend became apparent in June, 1955.

While the total tonnage ordered is running at a satisfactory level, the balance leaves something to be desired. Less than 10 per cent. of new orders in the past year were for export and the export proportion of the total order book dropped over the year from one-third to just over one-quarter. The preponderance of tanker tonnage in British yards has again asserted itself, thanks to the large orders placed by the big oil companies and certain of the big shipping lines in the autumn of last year. The loss of orders from foreign concerns in recent years has been largely caused by long delivery dates. The development of full employment in Western Germany and the very large increase in the output of ships from Japanese yards have forced both these countries to lengthen their delivery dates. It now remains to be seen if this change improves the United Kingdom's competitive position.

Meanwhile, concern and irritation are growing within the British shipping industry at the large volume of world tonnage now registered under flags of convenience. The question came up again last week at a meeting of the Council of the U.K. Chamber of Shipping. There is an increasing inclination among shipowners to investigate the possibility of operating British tonnage from ports of registration outside the country. It may not be long before a British company decides to test the law on whether a British company can, under certain circumstances, register ships overseas. Bermuda, with its recent plans for berthing and repairing large ships, is an obvious candidate for such a role within the Commonwealth. The issue so far as shipping companies are concerned is, of course, not one of dealing only with the international problem of flags of convenience. It is also complicated by the problem of taxation. Such companies want an easing in the burden of taxation. Behind the issue of flag discrimination therefore looms a principle of taxation—should shipping companies be allowed to avoid a burden of taxation which other British industries must bear and, if so, on what terms?

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Non-Ferrous Base Metals in the News

A major dip in copper prices, a continued and apparently intractable shortage of nickel, rising world output of titanium, the growing shortage of selenium and additional information on the properties of rhenium are some of the more interesting items relating to non-ferrous metals that have come through recently. Copper prices have dropped by over £70 a ton since early March and were still falling last week. The Rhodesian Selection Trust Companies announced a reduction of £35 to their fixed price, which is now £350 a ton and can be expected to remain at that level for some months. The very high price reached in March—£437 a ton—was due at least in part to threats of strikes, particularly in the Chilean mines. As soon as labour conditions appear stable, however, the price tends to fall, but this is by no means the only factor.

The growing consumption of copper in recent years has been due in large measure to a world-wide increase in the demand for consumer goods and cars, to the boom in house building and, of course, to the increases planned by most countries in the production and consumption of electricity. The fall in car output in the United States and the pessimistic statements of the industry's leaders have obviously had their effect on the way in which copper users have scheduled their purchases. There is yet no evidence that the demand for copper in Europe is declining or that substitutes are being used on a large scale. The Soviet Union has begun to import large quantities as was her custom pre-war (about 100,000 tons a year). Part of the fall in price is doubtless due to a deliberate contraction in stocks held by consumers, for few will take the risk of buying on a falling market. When they do decide to buy, the price will doubtless rise though perhaps not to its previous peak. It is too early to say that supply has caught up with demand but the vast mine development projects in Chile, Rhodesia and Canada should restore a balance within the next two to three years.

The continued shortage of nickel is a constant worry to users of nickel steels. The steel industry does not expect any relief for at least two years. In the United States the shortage is such that it is limiting output of stainless steel and has given rise to considerable pressure for diverting more nickel from the Government's stock pile. This may amount to 49 million pounds this year compared to 24 million pounds last year. But even diversions on this scale would do little to alleviate the long-term shortage and stainless steel producers are therefore afraid of losing a good many of their markets, for example to anodised aluminium which is making

a challenge in the manufacture of cars and domestic appliances. Another example is the use of titanium or zirconium for cladding mild-steel sheet and strip. Meanwhile stainless steel producers are working on the development of chromium stainless steels without any nickel. The growth of titanium output may prove to be the most important single factor in the situation and could radically alter the difficult nickel position within the next few years.

The restricted availability of selenium is causing concern among manufacturers of equipment requiring semi-conductor materials, such as transistors and rectifiers. The outlook is said to be so poor that several British companies are endeavouring to develop a super-purity silicon which is said to do the job even better than selenium. Most of the silicon at present used in this country is imported from the United States. The rapid growth of demand for transistors and rectifiers which is anticipated by the electrical, radio and instrument industries is likely to make the production of silicon metal one of the most important new developments in the British non-ferrous metal industry.

Rhenium is a new metal, practically unknown until recently, which is being developed by the Battelle Institute in the United States. It possesses outstanding tensile strength and high stress-rupture properties (the 100 hour rupture stress is estimated at 20,000 lb. per sq. in. at 1,000 deg. C. and 800 lb. per sq. in. at 2,000 deg. C.) Annealed rhenium sheet has a yield strength of 58·5 tons per sq. in., an ultimate tensile strength of 75 tons per sq. in and an elongation of 28 per cent. in one inch. Sheet reduced 30 per cent. by cold working has a yield strength of 126 tons per sq. in., an ultimate tensile strength of 144 tons per sq. in., and an elongation of 2 per cent. in one inch. The metal is obviously far from being a commercial proposition but it promises much, particularly in the growing number of applications where very high temperature resistance coupled to high tensile strength are required.

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Exhibitions in a College

The problem of introducing students to the more practical aspects of study is particularly acute in engineering, where developments occur quickly and where the relation of theory to practice can influence students' understanding of the basic needs of industry. A novel method of enabling students to broaden their practical knowledge is provided by a series of exhibitions that have been arranged by the librarian of the Westminster Technical College to demonstrate particular aspects of the courses being taken there.

Models and actual sections of machines are obtained with the co-operation of various firms and exhibited for a short time, during which the lecturer takes at least one class in the library and deals with the theory particularly relating to the group of items on show. The exhibitions were started about two years ago and have increased both in size and popularity. Firms have co-operated willingly and have offered far more material than can be accommodated. As an example of the subject matter, one exhibition dealt with compressors and included models of very large air compressors and also actual compressed-air tools. Another has dealt with Diesel engines, and since the college runs a special course in gas engineering, a suitable exhibition has already been planned.

The exhibitions change every fortnight and the engineering subjects alternate with those pertaining to the other courses being taken at the college. It is an interesting comparison that in the new university college of engineering at Wayne, Detroit, there is to be an exhibition of progress in engineering education and research to demonstrate the work of students during their four years in the college. Exhibitions of both kinds could be more extensively employed, and when, as in Westminster, they are held in the library, they can serve also to show the student his way about books and periodicals.

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Duty-Free Machinery

The Government have now adopted the advice of the consultative committee on the duty-free entry of machinery which examined the existing conditions on duty-free licensing of machinery in a report issued in July, 1954. It will be recalled that under section 10 of the Finance Act, 1932, provision was made for the importation of foreign machinery without payment of duty provided it was officially accepted that such machinery was " not for the time being procurable in Britain."

During the war, import duties on machinery were suspended, and after the war a system of exemption was administered by the Board of Trade with the advice of the Ministry of Supply. In a time of acute scarcity the volume of machinery brought in grew quickly and by the fiscal year 1951-52 the value of free imports amounted to £19·4 million, or 27·2 per cent. of all machinery imported. In the committee's report two years ago a case was made for the discretionary system of free importation of machinery, but on a more limited basis than had applied in the immediate past. It recommended that consignments of machinery should be considered for an import-free licence only when their value was £2,000 or more. This was done on the grounds that duty on machines of less value would not be an important consideration affecting their importation to an extent that would justify the amount of administrative work involved in considering individual cases. The committee also recommended that the scope of exemption should include plant (which was defined as " static machinery which performs industrial processes without moving parts ").

The Board of Trade has now announced that the remission of import duty will be considered when the user of a machine submits evidence to show that when he placed the order for the foreign machine no manufacturer of a similar machine in the U.K. could deliver within a period of two years, and that in cases where delivery by U.K. manufacturers was between 24 and 30 months the foreign delivery was within 15 months, or alternatively that where delivery by the U.K. manufacturer was more than 30 months the foreign delivery was within one half of the period. Certain conditions have also been laid down about the length of the validity of licences. The Board of Trade has thus adopted, although only in part, the recommendations of the Smith Committee.

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Bridging To-day and To-morrow

The Government have said that they are prepared to make a 75 per cent. grant towards the £2 million cost of the Runcorn-Widnes bridge. A contract for the bridge foundations has been let to Leonard Fairclough, Ltd., Adlington, and work is to begin immediately. The bridge, illustrated below, incorporates a central span of 1,082 ft.—the largest steel-arch span in Great Britain—and will replace an old transporter bridge which has, for 45 years, carried road traffic over the River Mersey and Mersey Ship Canal. The consulting engineers are Mott, Hay and Anderson, of London, who, incidentally, were the designers of the similar Tyne bridge constructed before the last war at Newcastle.

The new bridge is an example of the " set pieces " which Mr. Harold Watkinson, Minister of Transport, speaking at the annual dinner of the Institution of Civil Engineers, said he was anxious to see undertaken in this country. He was, he added, alarmed to note the experience that the Continental bridge builders had gained since the war. This contrast between the Continent and the United Kingdom must be recognised. We still have engineers who have had practical design and constructional experience on such bridges as Sydney Harbour and the Howrah Bridge, India. The calculation methods for determining the loads in principal members of these large bridges can be learnt out of text-books; designing the connections between such members cannot.

If the proposed Severn and Humber bridges were built end-to-end across London, they would reach from beyond the Bank to the Elephant and Castle. Such a project was mentioned recently by Mr. H. J. B. Harding during the discussion following a paper at the Civils. For about £20 million this would simultaneously resolve one of London's major through traffic problems (against £200 million for street widenings), would give us all the design experience we required to go bridge building for the rest of the world and, moreover, would be patent proof that we could do it.

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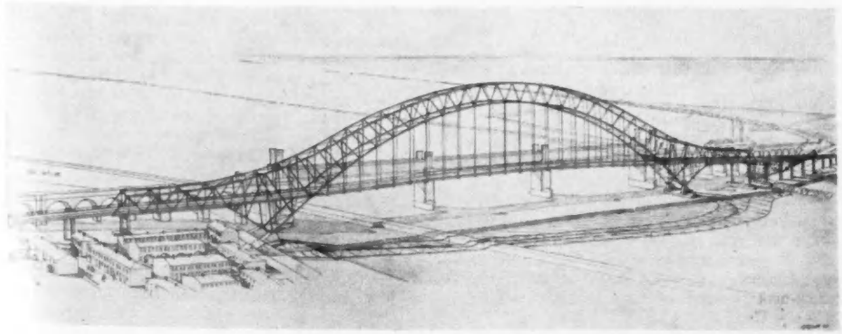
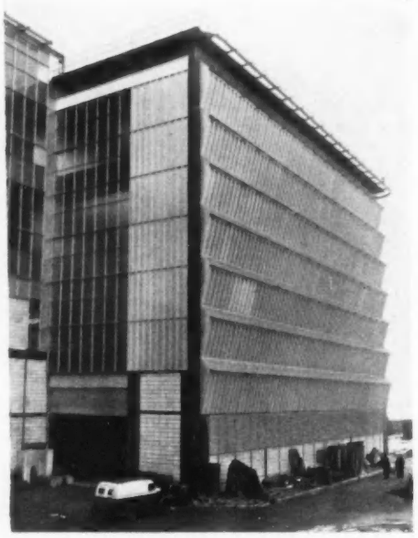
Russian Shopping List

The Soviet Government's intention to purchase goods from this country to the extent of £800 to £1,000 million in five years was the most concrete result of Marshal Bulganin's and Mr. Kruschev's visit to this country. The Prime Minister's Statement on the London talks states that the Russian's have left a shopping list and they have asked for the removal of restrictions on British exports to Russia. The items on the list are of considerable interest to the British metals and engineering industries. To some, such as machine tools, textile machinery, food processing machinery, mechanical handling and instruments, the increase in trade envisaged could bring most valuable orders. The background of Russia's need was examined in these columns last week (" What the Russians Want ").

There is little doubt that the needs are genuine enough. The main obstacle is the embargo list. It is not yet clear whether the Russians will immediately place orders for the two-thirds or so of the goods and raw materials mentioned which are not covered by strategic controls or whether they will wait until the restrictions have been removed. It could be their intention to use the two-thirds as a bargaining lever to secure their removal. Few engineering concerns have ex-



The Runcorn-Widnes road bridge, with the existing railway bridge just behind it. (See Bridging To-day and To-morrow).



Aluminium walls at Marchwood power station.

pressed agreement with the political trade embargos; several, including some of the oldest and most renowned in the industry, have been highly critical of strategic controls. They have pointed out that many European countries, including Western Germany, Sweden, France and Switzerland, have booked large Russian orders for ships, heavy electrical generating plant and for the most advanced types of modern machine tools.

The Russians propose that in five years ships and engineering products to the value of £363-£454 million should be purchased. The ships include two 10,000 ton cargo vessels, 20 fish carriers, 8 dredgers and 3 floating docks. This is less than was on the list previously presented in 1954, but a good many engineering items have been added. Machine tools constitute a most important part of the total. The fact that they tend to be of a type so far in limited production in this country could greatly assist the industry in filling the gaps in their range of special machines. Multi-spindle automatics and certain other types are subject to long delivery delays, but the prospect of large and regular orders could radically alter the attitude of an industry which, through bitter experience, remains fearful of over-production. The scope for the sale of chemical plant, plastic, woodworking, textile and printing machinery is very substantial indeed. All in all, British engineering has much to gain from the development of Anglo-Russian trade and from the trade that would follow with other countries in Soviet Eastern Europe.

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American Weed-Killers

A generation ago monopolies were taken for granted; at the present time they are automatically condemned, though there is little doubt that, kept within bounds, they may be beneficial to the community. The old I.C.I.-Du Pont agreement could perhaps be put in this class. It had its origin in the big Nobel Industries investment in General Motors in which Du Pont were, and still are, also big shareholders. It was concerned more with interchange of technical information than with price fixing, but it involved non-interference in the home market of the other party to the agreement. The co-operation in development of overseas markets was probably beneficial, and the growth of Canadian Industries Limited and some of the " Duperial " companies in South America was probably faster than it would have been if I.C.I. and Du Pont had competed in these markets.

Since the termination of the agreement, I.C.I. have started up in the United States and will, it is hoped, one day become a major dollar earner from that source, just as Courtaulds, Levers and more recently Bowaters have done. At present, so far as information is available, their business does not appear to be on a very big scale.

The recent entry of Du Pont into the British market with the production of herbicides, which will continue to be sold through Fisons Pest Control, Limited, is also a small venture (but one in a highly competitive section of the British chemical industry). It remains to be seen whether Du Pont intend to expand their bridgehead in Britain by major chemical enterprises or intend this more to be a kind of token competition, to be kept as such—perhaps so long as I.C.I. do not start up any major enterprises in the U.S. It is interesting that their partners should be Fisons, whose business tends to compete increasingly with certain branches of I.C.I. as they expand from the field of phosphate fertilisers.

The scope for herbicides seems to be enormous. It may go far beyond the range of phenoxyacetic acid and similar compounds on which the industry was originally based. If, for example, Dr. R. L. Wain, at Wye, keeps going we may expect not only a wide range of highly selective products for controlling different weeds in different crops but also non-toxic products which are converted to toxic products by enzymes present in the weed itself. There are important implications in these developments for the agricultural machinery industry as cultivation becomes more and more a chemical rather than a mechanical process. Certainly, much remains to be done in the field of application of herbicides (and fertilisers). The contracting firms maintaining specialised equipment for such work seem likely to benefit, as it is problematical how far general-purpose spraying equipment owned by the farmer himself is likely to be able to compete or even to prove suitable.

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Nationalised Industries and Parliament

The lamentable wrangle between the Minister of Transport and the Board of B.O.A.C. has high-lighted the dangers inherent in the control of a commercial concern by a political machine. The successive resignations over the past few months of Mr. Peter Masefield, Mr. Whitney Straight and Sir Miles Thomas have suggested that first-class men may be less and less willing to serve under the conditions that now prevail. The head of a Government department is in a much stronger position and yet does not have to balance his books. Mr. Watkinson has strongly suggested in his recent statements that the responsibility for B.O.A.C. and the shaping of the Corporation policy was his, and through him Parliament's.

The Prime Minister announced last week that the Government's view on this difficult question will be published within the next few weeks when he gives Parliament their considered reply to the special report by the Select Committee on Nationalised Industries. This Committee complained last year that they were unable to carry out their task of inquiry into the industries concerned because they were unduly restricted by their terms of reference. It is likely therefore that the Government will have a great deal of interpretation to do. Their statement will be awaited with considerable interest.

The problem is not easy. On the one hand the nationalised industries are dependent on the Exchequer and should therefore be answerable to Parliament for their financial results, which in fact means for their basic policy. On the other, these vast industries need the best men in the country to lead and administer them and few of the best men will be willing to expose themselves to constant sniping from politicians, and—more important still—to the enforced sharing of policy-making and of responsibility with politicians. The B.O.A.C. episode showed what extensive repercussions political interference can have on the executives within an organisation.

A solution could be found, or at any rate should be sought, on commercial lines. Why should nationalised industries be entitled to the taxpayer's money? To be made fully responsible for their financial results and for the finding of new funds could have a most salutory effect both on the rate of capital investment (it could be greater) and on the confidence and sense of responsibility of executives. While there are sound grounds for subsidising the development of nuclear physics or aircraft design, there are fewer for making air transport, or for that matter coal-mining, electricity generation, the Post Office, etc., the ultimate responsibility of the Exchequer. To those who argue that such organisations are of national importance and therefore a concern for the whole nation, one could reply " so are the aircraft industry and the steel industry (both subsidised), the motor industry (over-taxed) and so are engineering exports"—all of which are not answerable to Parliament. The need is for increased direct responsibility and increased autonomy as have industrial managements who each year are answerable to their shareholders at the annual general meeting. They have their responsibility to their bank manager, but the bank manager remains a servant, until a receiver is appointed.

★ ★ ★

Lightness by Aluminium Walls

Brickwork used merely as cladding for steel-framed buildings has had its day. Either the brickwork—expensive and slow to lay—is better replaced by large and quickly hung sheeting, or it should be used as an infilling that makes a positive contribution to the strength of the structure. Despite the admirable work of the Building Research Station to determine the assistance given by bricks to the framing, there is still little sign that engineers are prepared to include a worthwhile allowance for this added strength when designing new buildings. But both architects and engineers do appear willing to consider meeting the high cost of aluminium sheeting for wall cladding.

An excellent example of an aluminium-clad building is the turbine house at the C.E.A's new power station at Marchwood, near Southampton. As the accompanying photograph shows, the architect has obtained an exciting line which should enable the building to retain its attractive appearance even should some uneven oxidation occur. In conjunction with the glazing, the sheeting forms a saw-tooth wall which produces an interior lighting highly suited to the needs of a power station. Nevertheless, the architectural value of the sheeting would be far enhanced if a reasonably priced treatment enabled the aluminium to retain its pristine newness for the life-span of a building.

For Marchwood, the British Aluminium Company, Limited, have supplied the sheeting for both the turbine and boiler houses, for ancillary buildings and for the weather protection of the oil-fuel storage tanks. For the boiler house, the use of aluminium must have been almost imperative, for despite a sheeting weight of only 1 lb. per sq. ft., some of the main stanchions take loads of more than 2,000 tons down to the foundations.

The advantages of the sheeting are many and well-known. The cost is the difficulty—even allowing for the savings that accrue elsewhere by its use—but when £30 million is being spent on one power station, as is the case at Marchwood, there is a sound opportunity for experimenting with expensive innovations, and the C.E.A. are to be congratulated on doing so.

★ ★ ★

MR. J. R. H. OTTER, B.Sc.(Eng.), A.C.G.I., D.I.C., M.I.C.E., A.R.I.C.S., who has been with Rendel, Palmer and Tritton, for many years, was taken into partnership on April 6.

MR. ERNEST NORTON has been appointed a director of Yarrow and Co. Ltd., Scotstoun, Glasgow, W.4, and will be engaged primarily on work in connection with research and development.

ACHIEVING A CONSTANT RATE OF FLOW

THEORY OF THE FLOATING SYPHON

By T. H. Redding, M.SC., F.INST.P., A.M.I.MECH.E.*

In this device the action of a floating syphon is used to promote constant rate of flow. Actual and possible applications of the mechanism in a number of problems concerning flow control, dispensing, sampling, and constant-head viscometry are described.

It is surprising that only in isolated cases† has the device been reported in the literature of engineering hydraulics and modern process engineering since, as a means of regulating the flow of water, the apparatus was probably known to the hydraulic engineers of the Middle East, perhaps as early as the Fifth Century B.C. Having frequently used the floating syphon in various applications, the author thought some useful purpose might be served by a record of his own experiences with the device together with a theoretical analysis of its operation as a precision flow-rate regulator subject to temperature variation. Subsequently, in the treatment of other applications, special reference is made to constant head viscometry and design data given for a proposed large-scale viscometer which would permit the calibration of a conventional Rotameter-type flowmeter directly in terms of the dynamic viscosity.

The control of liquid rate of flow is the desideratum of many processes in chemical engineering and is often a pre-requisite of instrumental methods of quality control of industrial fluids; the problem by no means becoming easier as the scale of the project is reduced. For many purposes, where a free surface is available—or may be made available in the flow path—the floating syphon provides a simple and convenient method for effecting flow control.

The principle of the regulator is extremely simple and is self-evident on reference to Fig. 1, where the flow from the vessel A takes place through the float-mounted syphon B under the action of the constant head H.

THE REGULATOR

From its very nature, it is clear that the regulator can be constructed on scales ranging from small installations for laboratory use to large units for use in pilot or full-scale chemical-engineering plant. The most essential feature of the apparatus, from a constructional point of view, is to ensure stability of the float which carries the syphon. There is, therefore, much to be said for making the apparatus on a fairly liberal scale to accommodate a large float with sufficient spacing between it and the walls of the container to reduce surface tension effects to negligible proportions in relation to the up-thrust—even if the regulator is required only for the delivery of small rates of flow.

Fig. 2 shows diagrammatically the construction of a typical regulator in which a guide-rod D is an essential component to prevent the float drifting towards the walls of the container, the diameter of the rod being as small as possible consistent with its being rigid. If necessary, stability may be increased by the attachment of a weight to, but below, the float, to provide an appreciable metacentric height; in Fig. 2 this weight is shown in the form of a ring-weight E, carried on a yoke F. Finally it is necessary to provide an asymmetrically disposed counter-weight G to balance the overhang of that leg of the syphon situated outside the container. Conveniently the float can be made of wood or plastics material, or take the form of a loaded hollow cylindrical container. A float-form that is very convenient from the point of view of balancing is shown, in plan, in Fig. 3; the float taking the form of a raft formed by three cylindrical containers K, L, M, situated at the apexes of an equilateral triangle, and being joined together by welding wires or other more rigid connecting members N, O, P, according to the scale on which the regulator is being constructed. As previously, the centre of gravity can be lowered, as desired, by a ring-weight suspended from, and below, this triangular raft, which carries at its centre a small platform Q to support the syphon proper at R. A refinement which has the effect of increasing the steadiness of the flow is to provide a belled entrance J to the syphon tube so as to suppress entrance-contraction of the fluid-stream which, if present, could conceivably be subject to small periodic changes in area-ratio which would affect the flow-rate accordingly.

In the form described above, the regulator will deliver liquid at one fixed rate corresponding to the operating head determined by the vertical distance between the line of flotation of the float and the exit extremity of the syphon tube. However, if it is desirable to provide for a flow setting to be variable about a given norm, it is only necessary to provide means for varying the syphon-head; this is most easily done by moving the syphon, as a whole, up or down in a vertical direction with respect to the float, either manually or by a motor-operated mechanism carried on the float itself.

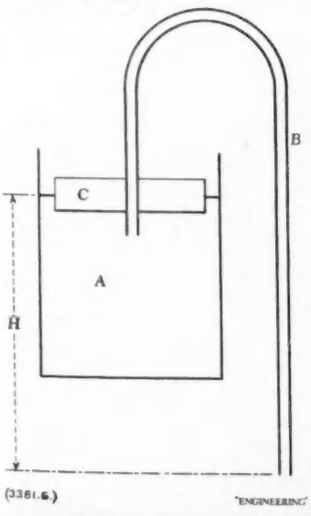

Fig. 1 In the floating syphon regulator, flow from vessel A takes place through the float-mounted syphon B under the constant head H.

THEORY

Direct application of Bernouilli's theorem to the extremities of the flow path between the surface of the liquid in the supply reservoir and the lower (exit) extremity of the syphon gives the relation between the flow rate and the syphon-head as

$$H = \frac{1}{2g}V^2 + \Sigma h \quad . \quad . \quad (1)$$

where H = syphon-head, i.e., the difference in level of liquid in the supply reservoir and the lower extremity of the syphon-tube;

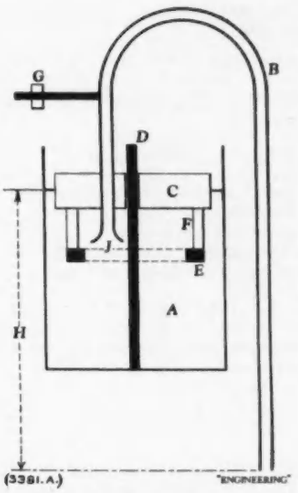

Fig. 2 Construction of the regulator. A guide rod D prevents the float drifting sideways; stability can be increased by a ring-weight E attached below the float. A counterweight G balances the overhang of the outer syphon leg.

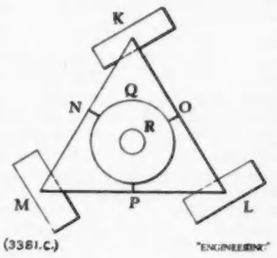

Fig. 3 The raft float (shown in plan) comprises three cylindrical containers K, L, M connected by members N, O, P. At its centre the raft carries a small platform Q supporting the syphon R.

V = mean velocity in the syphon at the exit reference section (X say) of diameter D;

$\Sigma h = h_1 + h_2 + h_3$ etc.—the head losses due to work done against friction in the various components (impedances*) of which the flow path is comprised.

For any one of the impedances in the stream, h is given by an equation of the form

$$h = f(Q, \rho, \eta, D_1, D_2, \ldots) \quad . \quad (2)$$

where Q = volumetric flow rate, ρ = fluid density, η = fluid viscosity, and D_1, D_2, D_3 etc., are the various dimensions which determine the geometry of the impedance in question.

The amount to which flow is viscous or turbulent within a given impedance will determine the extent to which h (and thus H) is dependent on temperature; since, in general, flow under turbulent conditions is less acutely dependent on η, and thus on temperature, than when flow is of the laminar form.

If the various h's are written in the form

$$h_1 = K_1\frac{V^2}{2g}, \; h_2 = K_2\frac{V^2}{2g} \text{ etc.} \quad . \quad (3)$$

equation (1) can be written in the form

$$Q = \frac{\pi D^2}{4}\sqrt{\frac{2gH}{1+\Sigma K}} \quad . \quad (4)$$

When—as is most usual—the syphon takes the form of a simple unobstructed tube of diameter D, equation (4) becomes

$$Q = \frac{\pi D^2}{4}\sqrt{\frac{2gH}{1+K_1+K_2+K_3}} \quad . \quad (5)$$

where K_1, K_2, and K_3 are the entrance, line, and exit friction loss-factors respectively.

† Stromeyer (ref. 3) uses a floating-syphon dispenser to control the flow of brine in a salt-titration method of stream-gauging.

* Member of the staff of the British Scientific Instrument Research Association.

* The term "impedance" is used here, and subsequently, in its mechanical sense, as a measure of the ratio pressure-drop/flow-rate.

Furthermore, when $R < 2{,}000$ laminar flow prevails and

$$K_2 = \frac{64\, l\, \eta}{D^2 V}\frac{1}{\rho} = \frac{16\, \pi\, \eta\, l}{\rho\, Q} \quad . \quad (6)$$

but when $R > 2{,}000$ the flow is essentially turbulent and

$$K_2 = \frac{\lambda\, l}{D} \quad . \quad . \quad . \quad (7)$$

R, λ and l being the Reynolds number of the flow, the resistance coefficient and the length of the syphon respectively.

Thus in laminar flow we can eliminate K_2 between equations (5) and (6) to give

$$\frac{H}{l} = \frac{8\, Q^2}{\pi^2\, g\, l\, D^4}\,[1 + K_1 + K_3] + \frac{128\, Q\, \eta}{\pi\, g\, \rho\, D^4} \quad (8)$$

whereas, in turbulent flow, K_2 may be eliminated between equations (5) and (7) to give

$$\frac{H}{l} = \frac{8\, Q^2}{\pi^2\, g\, l\, D^4}\,[1 + K_1 + K_3] + \frac{8\, Q^2}{\pi^2\, g\, D^4}\,\frac{\lambda}{D}. \quad . \quad . \quad . \quad (9)$$

Alternative forms of equation (9) useful in dealing with problems relating to design are as follows:

$$\frac{H}{l} = \frac{8\, Q^2}{\pi^2\, g\, D^5}\left[\frac{D}{l}\,(1 + K_1 + K_3) + \lambda\right] \quad (10)$$

$$= \frac{\pi^3}{128\, g}\left(\frac{\eta\, R}{\rho}\right)^5 \frac{1}{Q^3}\left[\frac{D}{l}\,(1 + K_1 + K_3) + \lambda\right] \quad . \quad . \quad . \quad (11)$$

$$\frac{H}{D} = \frac{8\, Q^2}{\pi^2\, g\, D^5}\left[(1 + K_1 + K_3) + \frac{l}{D}\,\lambda\right] \quad (12)$$

$$= \frac{\pi^3}{128\, g}\left(\frac{\eta\, R}{\rho}\right)^5 \frac{1}{Q^3}\left[(1 + K_1 + K_3) + \frac{l}{D}\,\lambda\right] \quad . \quad . \quad . \quad (13)$$

equations (11) and (13) being obtained by eliminating R between the expression for Reynolds number $\left(\text{i.e., } R = \frac{4\, Q\, \rho}{\pi\, D\, \eta}\right)$ and equations (10) and (12) respectively.

It should be noted that whilst formulae (8) to (13) are complete and exact, calculations based on these formulae which neglect K_1 and K_3 are necessarily approximate—as also are calculations in the turbulent zone in which established values of λ are applied to pipes less than 2 in. in diameter or having a length-to-diameter ratio less than 100. In what follows we shall assume $K_1 = K_3 = 0$ in all cases, unless statement is made to the contrary. In practice, however, the method of mounting the syphon on a float provides a ready means for bringing an approximately dimensioned syphon into exact calibration by precise adjustment of the operating head, as effected by moving the syphon, vertically, as a whole, in the fixture which attaches it to the float.

DESIGN ROUTINE

Assuming in the first instance that turbulent conditions prevail, it is evident that, for a given value of Q, values of D, l and H have to be chosen in such a combination as to satisfy equation (9); but, at the same time, each of these factors, and certain of their ratios, need to be within limits determined by the physical and practical considerations of the problem in hand. Thus, apart from practical considerations—which vary enormously according to the purpose for which the regulator is required and on the scale to which it is to be made—the following physical considerations set definite limits to values that may be chosen for D, l and H for a required value of Q :

(1) D must not be so large that $V < V_{min.}$ where $V_{min.}$ is determined by the nature of the fluid, being a factor which tends to increase in proportion to the amount of dissolved gases in the liquid, which at low flow-rates might tend to cause vapour-locking and de-priming. Also, preferably, D should not be so large that $R < 2{,}000$ otherwise the regulator might well become excessively sensitive to temperature changes:

i.e., $D < D_{max.}$ (say).

(2) Ratio $\frac{l}{D}$ must not be so large as to give rise to excessive changes of Q with changing temperature :

i.e., $\frac{l}{D} < \left(\frac{l}{D}\right)_{max.}$ (say).*

Reference to equation (10) shows that these two factors (1) and (2), taken together, automatically set a limiting maximum value to $\frac{l}{H}$, thus:

$$\left(\frac{l}{H}\right)_{max.} = \frac{1}{\dfrac{8\, Q^2}{\pi^2\, g\, D^5_{max.}}\left[\dfrac{1}{\left(\dfrac{l}{D}\right)_{max.}} + \lambda\right]} \quad (14)$$

(3) $H < (H_A)_{max.}$

where H_A is the vacuum-head (with reference to the atmosphere) at the highest point (apex) of the syphon.

$(H_A)_{max.}$ is, theoretically, the barometric head in terms of the syphon-fluid, but in practice is confined to a fraction of this theoretical value, due to its being necessary to suppress any tendency for cavitation to take place.

For a given operating head, this condition sets limits on the distribution of impedance above and below the free surface of the reservoir when taken in relation to the elevation of the apex. This problem is discussed at length in many standard works on hydraulics, but is not often encountered in process or chemical engineering since practical considerations usually ensure comparatively small values for the elevation of the apex.

(4) H must be sufficiently large in comparison with D to ensure the permanent and steady operation of the syphon without risk of de-priming due to entraining air at the exit,

i.e., $\frac{H}{D} > \left(\frac{H}{D}\right)_{max.}$ (say).

The author's experience suggests $\frac{H}{D} = 6$ as a suitable value for this ratio.†

(5) In addition to the above, there are certain quantities whose values are limited by virtue of the geometry of the system. These are as follows:

(*a*) $\frac{l}{H} > 1$‡

(*b*) $l - H > 2\,L$‡

where L is the required float lift.

From the point of view of the effect of temperature on calibration, discussed later, it should be noted that conditions (4) and (5a) cited above automatically set limiting minimum and maximum values, respectively, for the permissible Reynolds number (taken in relation to the length of the syphon) relevant to a given flow-rate capacity Q—reference to equations (13) and (11) giving these limits as:

$$R^5 > \frac{6 \times 128\, g}{\pi^3}\left(\frac{\rho}{\eta}\right)^5 Q^3\, \frac{1}{1 + \dfrac{l}{D}\,\lambda} \quad . \quad (15)$$

$$R^5 < \frac{128\, g}{\pi^3}\left(\frac{\rho}{\eta}\right)^5 Q^3\, \frac{1}{\dfrac{D}{l} + \lambda} \quad . \quad (16)$$

As might well be expected, it is by no means always possible to accommodate a proffered value of Q, having regard to the above limitations. In particular, in cases where it is required to provide extremely small flow rates it often happens that for $R > 2{,}000$, D needs to be so small that the requisite head to promote a specified flow rate lies outside the limits of practicability. In these cases there is no alternative but that of designing on the basis of laminar flow—using equation (8)—and to tolerate the temperature effects so introduced.

The method used to determine optimum dimensions of the syphon in any given case, will vary according to whether or not the effect of temperature change is to be taken into account.

If temperature changes do not occur, or if the degree of control is such as to permit temperature effects being neglected, syphon dimensions may be chosen approximately from a simple family of curves in which H is plotted as a function of l for selected constant values of D. Examples of such curves are shown in Fig. 4, which refers to a syphon designed to deliver water at 20 deg. C. at a rate of 12·65 cc. per sec. These curves have been derived by the direct application of equation (10)† and, as drawn, exclude all values of D which render $R < 2{,}000$, pairs of values of H and l, and of H and D which render ratios $\frac{H}{l}$ and $\frac{H}{D}$ greater than 1 and less than 6, respectively. (In practice, however, it can happen that, for a given H, (or l), the factor $\frac{l}{D}$ becomes impractically small before $\frac{H}{l}$ has reached its limiting value of unity.) After such a preliminary survey of the problem, exact and convenient values of H and/or l are computed to correspond to a value of D " rounded " to suit a standard pipe size.

* That limiting the ratio $\frac{l}{D}$ gives control over the flow-rate error due to change in temperature, is evident by differentiating equation (9) with respect to temperature T to give

$$\frac{dQ}{Q} = -\frac{1}{2}\,\frac{1}{\left(1 + \lambda\,\dfrac{l}{D}\right)}\,\frac{l}{D}\,\frac{d\lambda}{dT}\,dT.$$

† Purely theoretical considerations suggest a maximum value of the Froude number $F = \frac{4\, Q}{\pi\sqrt{g\, D^5}}$ as being the factor which determines safe (i.e. permanent) running of the syphon. This in turn implies a maximum value of $\frac{H}{D}$ which varies according to the length of the syphon.

‡ More strictly these conditions are (*a*) $\frac{l}{H} > C_1$ (*b*) $l - H > 2C_2\,L$, where C_1 and C_2 are factors, approximating to unity, which take into account the finite length of the apex-bend.

* In reviewing a problem in which $\frac{l}{D}$ is a factor to be determined, a guide as to probable values of the above limits can be obtained by use of formula (15) and (16) with $\frac{l}{D} = 0$ and $\frac{l}{D} = \frac{1}{20}$ respectively. Such values are likely to be safe values, the maximum overestimation of $R_{min.}$ and underestimation of $R_{max.}$ being of the order 35 per cent. and 20 per cent. respectively.

† Using accepted values for λ at given values of R — see for example plot of λ versus R for smooth pipes (after Blasius and Nikuradse) given by B. A. Bakhmeteff in *Mechanics of Turbulent Flow* (Princeton University Press).

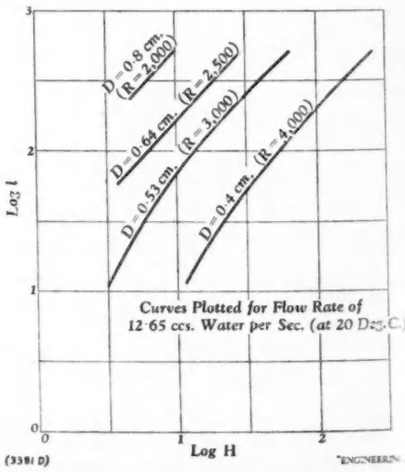
D = 0·8 cm. (R = 2,000)
D = 0·64 cm. (R = 2,500)
D = 0·53 cm. (R = 3,000)
D = 0·4 cm. (R = 4,000)
Curves Plotted for Flow Rate of 12·65 ccs. Water per Sec. (at 20 Deg. C.)
Log l
Log H
0
1
2
3

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Fig. 4 Variation of syphon head H with syphon length l for constant values of diameter D. Flow rate 12·65 cc. of water at 20 deg. C.

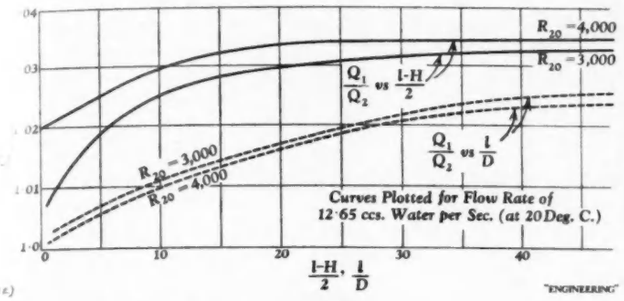
$R_{20} = 4{,}000$
$R_{20} = 3{,}000$
$\frac{Q_1}{Q_2}$ vs $\frac{l-H}{2}$
$\frac{Q_1}{Q_2}$ vs $\frac{l}{D}$
$R_{20} = 3{,}000$
$R_{20} = 4{,}000$
Curves Plotted for Flow Rate of 12·65 ccs. Water per Sec. (at 20 Deg. C.)
$\frac{l-H}{2}$, $\frac{l}{D}$
"ENGINEERING"

Fig. 5 Typical curves of $\frac{Q_1}{Q_2}$ plotted against $\frac{l-H}{2}$ and $\frac{l}{D}$ for constant Reynolds numbers. Q_1 and Q_2 are the flow rates at temperatures T_1 and T_2, respectively.

CONTROL OF TEMPERATURE ERROR

In this case it is required to design the syphon to have a minimum temperature error, it being anticipated that this will impose limits on other pertinent parameters, and in particular on the operating head and the maximum permissible float-lift. Thus we shall consider the problem of designing for minimum error consequent on the temperature changing from T_1 to T_2, where T_1 is the temperature at which the syphon delivers its rated capacity Q_1 (say). To facilitate the argument we shall assume $T_2 < T_1$.

If η_1 and η_2 ($\eta_2 > \eta_1$), λ_1 and λ_2 ($\lambda_2 > \lambda_1$), Q_1 and Q_2 ($Q_2 < Q_1$) and R_1 and R_2 ($R_2 < R_1$) are the viscosities, friction coefficients, flow rates and Reynolds numbers at temperatures T_1 and T_2, respectively, consideration of equation (10), with $K_1 = K_3 = 0$, gives at once

$$\left(\frac{Q_1}{Q_2}\right)^2 = \frac{1 + \lambda_2 \frac{l}{D}}{1 + \lambda_1 \frac{l}{D}}, (\lambda_2 > \lambda_1) \qquad (17)$$

from which it should be noted that $\frac{Q_1}{Q_2}$ decreases towards unity with decreasing $\frac{l}{D}$, but tends to the limiting value $\sqrt{\frac{\lambda_2}{\lambda_1}}$ as $\frac{l}{D}$ tends to ∞.

However, although for the same temperature change, $d\lambda$ tends to decrease with increasing R, this effect is very small—at least over that range of Reynolds numbers which are practicable in so far as syphons are concerned. In general, no advantage is gained by designing at Reynolds numbers much in excess of the practicable minimum (as governed by minimum R to ensure values of $\frac{H}{D} > 6$, or turbulent flow at all working temperatures, whichever is the larger), since at high Reynolds number we cannot reduce $\frac{Q_1}{Q_2}$ to a value appreciably less than $\sqrt{\frac{\lambda_2}{\lambda_1}} \times \left(\text{the limit of } \frac{Q_1}{Q_2} \text{ as } \frac{l}{D} \to \infty\right)$, by virtue of reducing $\frac{l}{D}$, without severely limiting the lift or giving rise to impracticable values for the operating head (i.e., $H > l$). This follows from consideration of equation (10), regarding λ as being constant over the range of permissible values for R defined by equations (15) and (16).

On the other hand, designing at lower Reynolds numbers offers the possibility of reducing $\frac{Q_1}{Q_2}$ to a value well below that of $\sqrt{\frac{\lambda_2}{\lambda_1}}$ by suitable choice of the ratio $\frac{l}{D}$—but this, admittedly, at the expense of limiting the permissible lift.

Exactly how design at various Reynolds numbers affects the temperature error in any given problem is best reviewed by using equation (17) to construct the family of curves $\frac{Q_1}{Q_2}$ versus $\frac{l}{D}$ for selected constant values of R_1. From this basic relation it is a simple matter to derive any or all of the curves: $\frac{Q_1}{Q_2}$ versus H, $\frac{Q_1}{Q_2}$ versus l, $\frac{Q_1}{Q_2}$ versus $\frac{H-l}{2}$, for selected constant values of R_1—so revealing the extent to which a desired maximum value of $\frac{Q_1}{Q_2}$ will impose limits on the operating head and/or on the maximum permissible lift.

These points are illustrated in the following example, where we consider the problem of designing a syphon to deliver 12·65 cc. of water at a temperature of 20 deg. C., with the least possible temperature error over the range 20 deg. C. to 10 deg. C.

Here it is interesting to compare the operation of syphons designed to operate at Reynolds numbers of 3,000 and 4,000, respectively.

With $R_{20} = 4{,}000$, we have

$$\begin{cases} \lambda_{20} = 0{\cdot}040 \quad \eta_{20} = 0{\cdot}01 \text{ poise,} \\ D = \dfrac{4\,Q\,\rho}{R\,\pi\,\eta} = \dfrac{12{\cdot}65 \times 4}{4{,}000\,\pi\,(0{\cdot}01)} = 0{\cdot}4025 \text{ cm.} \end{cases}$$

$$\eta_{10} = 0{\cdot}013 \text{ poise, } R_{10} = \frac{\eta_{20}}{\eta_{10}} R_{20} = 3{,}076$$

$$\lambda_{10} = 0{\cdot}043, \sqrt{\frac{\lambda_{10}}{\lambda_{20}}} = 1{\cdot}037.$$

With $R_{20} = 3{,}000$,

$$\begin{cases} \lambda_{20} = 0{\cdot}0433, \ \eta_{20} = 0{\cdot}01 \text{ poise,} \\ D = \dfrac{12{\cdot}65 \times 4}{3{,}000\,\pi\,(0{\cdot}01)} = 0{\cdot}5333 \text{ cm.,} \end{cases}$$

$$\eta_{10} = 0{\cdot}013 \text{ poise, } R_{10} = 2{,}308,$$

$$\lambda_{10} = 0{\cdot}0466, \sqrt{\frac{\lambda_{10}}{\lambda_{20}}} = 1{\cdot}038.$$

At each value of R_{20} we now select convenient values of $\frac{l}{D}$ and, knowing D, calculate corresponding values of $\frac{Q_1}{Q_2}$*, $\frac{H}{l}$*, l, H, and $(l - H)$, to derive the curves shown in Fig. 5 in which the maximum lift $\left(\frac{l-H}{2}\right)$ is plotted as a function of $\frac{Q_1}{Q_2}$. In this case the disadvantage of designing at high Reynolds numbers is at once apparent, since for $R_{20} = 3{,}000$ we can realise a temperature error of less than 2 per cent. if the lift is restricted to values less than 6 cm. (see Fig. 5), whereas for $R_{20} = 4{,}000$, the lift would have to be reduced to its limiting value of zero $\left(\text{corresponding to } \frac{H}{l} = 1\right)$ in order to realise the same temperature error of 2 per cent.—an error-factor which in itself represents a 40 per cent. reduction on the inherent temperature error associated with large values of $\frac{l}{D}$.

A typical solution at $R_{20} = 3{,}000$, which accepts $\frac{Q_1}{Q_2} = 1{\cdot}022$, gives $\frac{l}{D} = 30$ $\left(\text{from a plot of } \frac{Q_1}{Q_2} \text{ against } \frac{l}{D}\right)$ whence $l = 0{\cdot}5333 \times 30{\cdot}0 = 16{\cdot}00$ cm. and thence apply equation (10) to give H as 3·65 cm.

* Using equations (17) and (10) respectively.

It should be noted that the impedance of the syphon-tube need not be that of a simple tube—we can, for example, utilise the excellent temperature-independent flow-characteristics of sharp-edged orifices (of small sectional area compared with that of the approach main in which they are installed) instead of, or in conjunction with, tube-impedances. Thus, for example, Johansen's data[1] on small orifice plates can be used to determine an orifice of diameter 0·29 cm. situated at the extremity of a 2 cm. diameter syphon-tube as being suitable for delivering 12·65 cc. per second of water at 20 deg. C., under a head of 50 cm. water gauge. In this instance reference to Johansen's plot of orifice-coefficient versus Reynolds number for such an orifice determines the temperature dependance of the syphon, as a flow-rate regulator, to be of the order 0·13 per cent. change in rate-of-flow per deg. C. In fact, arranging for the fitting, at will, of interchangeable end-cap orifices provides a convenient means of changing the range of the regulator without altering its overall length. However, in spite of their convenience, orifices cannot be used where the operating fluid is a slurry, due to the build-up of the solid constituent against the upstream face of the orifice with consequent introduction of large metering errors.

TEMPERATURE COMPENSATION

It has been shown that change in temperature gives rise to change in flow-rate capacity by virtue of the loss factor Σ K in equation (4) being dependent on viscosity, which, in turn is dependent on temperature.

However, over a limited range of temperature, the flow rate could be maintained constant by varying H just sufficiently to compensate for changes in the loss factor Σ K; this being effected practically by fixing the syphon in a mount which is movable in the vertical direction and which, when actuated by a thermosensitive device raises or lowers the whole syphon relative to the float, thus effecting changes in the operating head. A simple analysis shows that a linear compensator—in which the syphon movement is proportional to the temperature change—is only completely effective if the factor $(1 + \Sigma K)$ varies linearly with temperature. It must therefore be anticipated that compensation by automatic head-adjustment is only practicable over relatively small temperature ranges. In laboratory-scale regulators, such compensation could no doubt be effected from the action of a totally immersed thermosensitive metal bellows mounted on a yoke attached to the underside of the float.

SPECIAL APPLICATIONS: IRRIGATION CONTROL

The main use of the floating syphon in its large-scale application would appear to be that of a dispenser or sampler, operating from open tanks, or from low-pressure mains which can be arranged to include metering tanks. In particular, the device could be used to control the flow of water in the final stages of crop irrigation in cases where this process is complicated by large variation of the water level in supply reservoirs.

It is indeed surprising that such a simple device, in one form or other, is not in more general use for this purpose; especially when, as in the Maltese Islands (where agricultural water-supply is usually from local wells) the storage head is subject to variation but is never itself very large. Under these conditions (as opposed to cascade-systems of terraced gardening) level control is impracticable and, to a degree, the adjustment of perimeter channel outlets to compensate for variations in storage head must be a troublesome matter. Prejudice against the introduction of the regulator would no doubt be based on the mechanical equipment necessary to prime the syphon, but here modern design and non-corrodible materials could probably provide cheap and reliable equipment for this purpose. Furthermore, in small reservoirs, evaporation losses might be reduced by making the float so large as to nearly cover the surface of the water.

Within limits, the operation of the syphon is independent of the rate, but not of the acceleration, at which the liquid surface rises or falls in the sampling reservoir, so that the liquid level in the tank may be kept reasonably constant—without affecting the operation of the regulator—by the use of a conventional ball-float-operated inlet valve; alternatively electric contacts carried on the syphon could control the current to an electro-magnetically operated inlet valve.

An alternative method of sampling, applicable to low-pressure mains not subject to large changes (or large rates of change) of the flow rate, is shown diagrammatically in Fig. 6, where a main S is shown feeding a metering tank, T, the level of the liquid in which is determined by the size of a fixed orifice U at the entrance to the exit main V. The floating syphon follows the level of the liquid in the metering tank and so delivers a sample at a constant rate independent of the main rate of flow.

By such arrangements the action of the syphon is rendered virtually continuous and provided with a nearly-stationary delivery port.

SAMPLING CORROSIVE LIQUIDS

In its small-scale application the apparatus is of most use as a sampling device, as, for example, in the supply of small but constant rates of flow to instruments for determining chemical composition by physical means. It is particularly suitable for sampling or dispensing small quantities of valuable or corrosive liquids—such projects are themselves instances where flow-rate controllers incorporating overflow devices are clearly undesirable.

For controlling very small rates of flow, the apparatus appears to be free of tendency to impose a high-frequency periodic variation of the flow rate, as is often present in small-scale flow-rate controllers working from constant-head devices which utilise overflows—due, presumably, in this latter case, to periodic variations in the head arising from surface-tension effects at the entrance to the overflow pipe.

METER CALIBRATION

A particular small-scale application is in the calibration of low-rate flowmeters, especially meters of the variable-area Rotameter type, since if the Rotameter is included in the riser arm of the syphon, the flow rate may be varied over the complete working range of the instrument by sliding the syphon up or down through an easy push-fitting gland in the float itself.

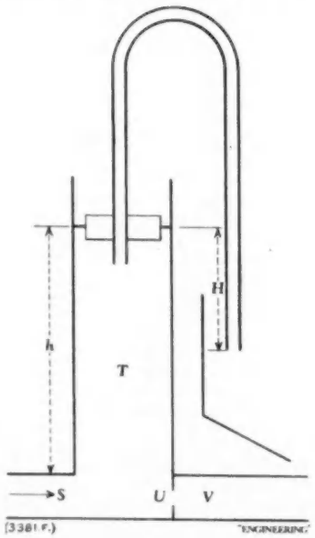

Fig. 6 Sampling from low-pressure mains. The main S feeds a metering tank T, the level of which is determined by the size of a fixed orifice U at the entry to the exit main V. The floating syphon follows the level of liquid in the metering tank.

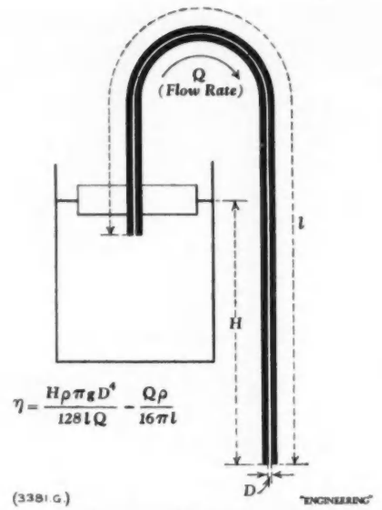

Fig. 7 In the constant-head viscometer, designed to operate at Reynolds number less than 2,000, the whole syphon tube is of such diameter as to ensure laminar flow at all points in its length, and the flow rate is a function only of the viscosity and density.

To a degree such a calibrator is temperature-dependent, but in a calibrating room subject to unavoidable temperature changes this effect can be minimised by choice of a calibrating liquid of low viscosity index (e.g. silicone fluids).

Similarly the apparatus may be used to calibrate low-range low-impedance gas meters by arranging for the liquid-discharge to displace air from a container connected to the gas-flow-meter under test, the syphon entrance to the container being sealed by a flexible bellows to accommodate its motion in a vertical direction. Under these circumstances the inlet of the meter under test will be supplied with air at a pressure slightly above that of the atmosphere (due to its own impedance) so reducing the effective syphon head to a value (H-h'), h' being the air pressure, expressed as head of the liquid in the container into which the syphon discharges.

Application as a Control Valve.—As in the flowmeter calibrating arrangement previously described, the syphon may be used, virtually, as a valve for controlling flow-rate without altering the resistance of the stream path, simply by varying the vertical position of the syphon-tube with respect to the float; this may be done by a simple sliding fitting, as previously described, or, for fine control, by the action of a short length of lead-screw actuating a captive nut attached to the syphon tube itself. For convenience the riser tube can be approximately calibrated in terms of the rate of flow corresponding to juxtaposition of the graduations on the tube and an index attached to the float. A modification of such an arrangement could be used for programming flow rate in the micro-flow range, since a small motor-operated mechanism can be carried on the float itself for the purpose of moving the syphon-tube up and down according to a predetermined lift-versus-time formula.

CONSTANT-HEAD VISCOMETRY

Possible uses of the regulator in constant-head viscometry are at once apparent, since if the syphon is designed to operate at Reynolds numbers less than 2,000 the flow will necessarily be laminar; under the action of the inherent constant head, conditions will be such as to render the flow-rate a function only of the viscosity and density. The possibilities of using the regulator in this application in conjunction with existing forms of partially viscous-independent flow meters are discussed in the following section.

In this application the syphon tube itself, or a portion thereof, is so dimensioned with regard to a chosen pressure gradient as to ensure laminar flow, that is, it is designed to operate at a Reynolds number less than 2,000—the lower critical Reynolds number corresponding to the incidence of turbulent flow.

Thus, in the viscometer shown in Fig. 7, the whole syphon tube is of such diameter as to ensure laminar flow at all points in its length, so that the viscosity is given approximately by re-arranging formula (8) to give

$$\eta = \frac{H\rho\pi g D^4}{128 l Q} - \frac{Q\rho}{16\pi l} \quad . \quad (18)$$

Q being determined experimentally by direct observation of the time required to deliver a measured quantity of fluid.

Provided that the tube dimensions are such as to render the effects of end accelerations* and the curvature of the bend to negligible proportions, that no deformation of the tube cross-section occurs in the bend, and that this is made in such a way that the overall length of the syphon can be accurately measured, equation (18) can be applied for accurate determinations of η, otherwise resource to empirical calibration must be made.

Alternatively, a large-bore syphon could be used as a feeder to a straight length of precision-bore capillary tubing, but in this case an additional pressure measurement would need to be made at the entrance to, or at some point in, this length of capillary, in order to determine the precise operating head in so far as the metering-impedance is concerned.

The above arrangement of a floating-syphon sampler operating entirely within the range of laminar flow would be admirably suitable as a means of continuously measuring viscosity in industrial applications were it not for the difficulties involved in measuring Q *directly* under viscous-independent conditions.

It is indeed unfortunate that conventional

* This condition, if satisfied, implies such small values of Q that the term $\frac{Q\rho}{16\pi l}$ in equation (18) can be effectively equated to zero to give the usual Poiseuille formula for streamline flow.

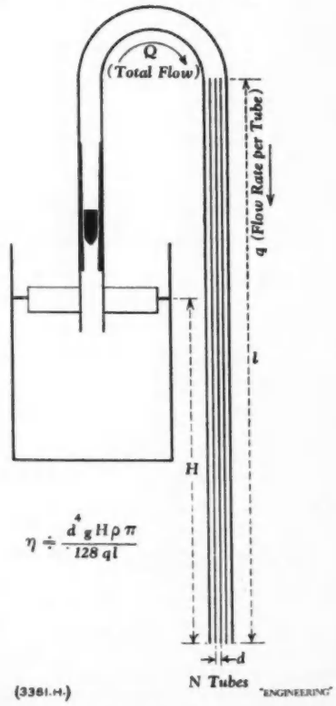

Fig. 8 Rotameter-adapted constant-head viscometer; in this, the Rotameter is placed before a flow divider which splits the flow into N similar streams each dimensioned to ensure a Reynolds number equal to or less than 2,000.

ercially available variable-area flowmeters (meters)—which would otherwise be admirable for this purpose—are characterised by fluctuate readings which are dependent on viscosity to an extent which increases as the range of the instrument decreases towards normal "sampling" speeds. Thus, for example, viscosity-independent flow metering at unit specific gravity in the viscosity range 0-70 centipoises is probably only possible with Rotameters rated in excess of 60-3,000 gallons per hour. Needless to say, by any standards, such flow rates as these are far in excess of any permissible "sampling rate."

However, in special cases where the viscosity and the range of viscosity to be measured is small (of the order 2-10 centipoises), the Rotameter-adapted floating-syphon viscometer should be a practicable tool, provided that fairly large sampling rates are permissible—as can be seen from the following calculation based on a typical, and commercially available, Rotameter rated, at unit specific gravity, at 22-110 gallons per hour and which, being sized for a $\frac{3}{4}$ in. main, provides viscosity-independent indications of flow-rate over its whole range for all viscosities less than 13 cp.

In this design the flow path should be such that the Rotameter is placed before a flow-divider which splits the flow into N similar streams each of which is so dimensioned (as shown diagrammatically in Fig. 8) to ensure a Reynolds number equal to or less than 2,000; so that for the most part the resistance to flow in the syphon is the consequence of laminar flow for which

$$Q \propto \frac{1}{\eta}. \quad . \quad . \quad (19)$$

If now $\eta_{min.}$ and $\eta_{max.}$ are the lower and upper limits respectively of the viscosity range over which it is required to measure, and if the downstream impedance is so dimensioned that

$$\text{when } \eta = \eta_{min.}, \ Q = Q_{max.} \quad . \quad (20)$$

where $Q_{max.}$ is the approximate (i.e., nominal) flow-rate capacity of the Rotameter:

then, when $\eta = \eta_{max.}$,

$$Q = Q_{max.} \frac{\eta_{min.}}{\eta_{max.}} = Q_{min.} \text{ (say)}. \quad (21)$$

Thus, with the instrument cited above (effective scale 22-110 gallons per hour), we can measure viscosity, with full-scale sensitivity, between the limits $\eta_{max.}$ and $\frac{\eta_{max.}}{5}$, provided that $\eta_{max.}$ itself does not fall below the 13 cp. viscosity ceiling of the instrument. In this case, $\eta = \eta_{max.}$ when $Q = Q_{min.} = 22$ gallons per hour; $\eta = \eta_{min.}$ when $Q = Q_{max.} = 110$ gallons per hour; and for $\eta_{max.} < \eta > \eta_{min.}$,

$$\frac{Q}{Q_{max.}} = \frac{1}{\left(\frac{Q_{max.}}{Q_{min.}}\right)\left(\frac{\eta}{\eta_{max.}}\right)} = \frac{Q}{5\left(\frac{\eta}{\eta_{max.}}\right)} \quad (22)$$

an equation which, following from (19), determines the viscosity-scale shape in terms of a uniformly divided flow scale; it is represented graphically in Fig. 9. In the construction of modern Rotameters, the sectional area of the flow-tube varies over its length in such a way as to produce a tolerably uniform flow-scale over the range 20-100 per cent. of its flow-rate capacity; so that the actual scale "viscosity versus Rotameter displacement" will be sensibly the same as the "Q versus η-scale" given by equation (22). Moreover, if an electrically transmitting instrument is used, some linearisation of the viscosity scale could be introduced—and with considerable advantage in so far as the lower-viscosity end of the scale is concerned.

Finally, it should be noticed that some discretion and possible compromise between conflicting practical requirements are likely to be necessary in designing the impedance which follows the flowmeter and which, of necessity, must show the inverse flow-rate versus viscosity characteristic of equation (19) and which for practical reasons should have the smallest possible number of parallel laminar-flow paths. In particular, in the final choice of operating Reynolds number for each of the individual

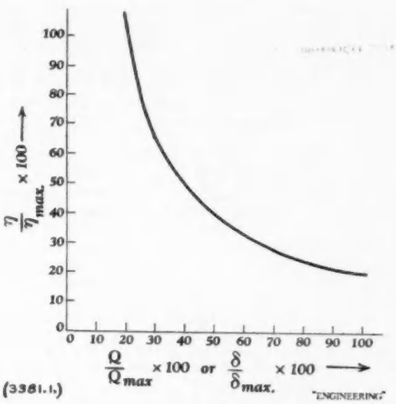

Fig. 9 Relation between $\frac{Q}{Q_{max.}}$ and $\frac{\eta}{\eta_{max.}}$ for a Rotameter-adapted constant-head viscometer, based on $\eta = \eta_{max.}$ when $Q = \frac{Q_{max.}}{5}$.

laminar flow paths, consideration has usually to be given to the problem of arranging the maximum flow rate per tube ($q_{max.}$) to be an integral part of the nominal meter rating $Q_{max.}$ to ensure an integer value for N, the number of flow paths involved.

In this connection the particularisation of equation (5) to the composite syphon of Fig. 8 shows η as being given by the expression

$$\eta = \frac{d^4 g H \rho \pi}{128 q l} - \frac{q \rho}{16 \pi l} \quad . \quad (23)^*$$

where d, l and q are the diameter, length and flow-rate capacity, appertaining to each of the N individual laminar-flow elements (capillaries) and where, in deriving the formula, entrance, exit, and Rotameter-tube frictional losses have been neglected.

Assuming l is made sufficiently large to permit neglecting the term $\frac{q\rho}{16 \pi l}$, we have

$$\eta = \frac{d^4 g H \rho \pi}{128 q l}. \quad . \quad . \quad (24)$$

Also, if r is the Reynolds number of the flow in each of the capillaries

$$r = \frac{4 q}{\pi d} \frac{\rho}{\eta} \quad . \quad . \quad (25)$$

when q may be eliminated between equations (24) and (25) to give

$$d^3 = \frac{32 r}{\rho^2} \eta^2 \frac{1}{g} \frac{l}{H} \quad . \quad . \quad (26)$$

an equation which determines d in terms of η, ρ, and arbitrarily chosen values of r and $\frac{l}{H}$. Thus, for example, if the above Rotameter is required to measure viscosity over the range 2-10 cp. we keep the number of tubes as small as possible by setting r at its maximum permissible value (i.e., $r = 2{,}000$) at maximum flow (when η is a minimum = 2 cp), and setting $\frac{l}{H} = 1{\cdot}5$—a convenient value for this ratio—use equation (26) to determine $d = 0{\cdot}339$ cm. Using this value of d in equation (24) with η again at its minimum value (2 cp.), and $\frac{l}{H} = 1{\cdot}5$ as before, we compute the maximum flow rate per capillary as $q = 10{\cdot}66$ cc. per sec., which is almost exactly one-thirteenth part of the normal flow-capacity of the Rotameter tube (110 gallons per hour = $138{\cdot}7 = 10{\cdot}67 \times 13$ cc. per sec.)

A length of syphon of 100 cm. is sufficient to reduce the factor $\frac{\rho q}{16 l \eta}$ (of equation 23) to the order of 1·5 per cent. of the viscosity corresponding to maximum flow (i.e., $\eta = 2$ cp.), where its influence is most apparent. However, the presence of this factor is not entirely disadvantageous, since it has the effect of partially linearising the scale in the range of lower viscosities; but this, admittedly, at the expense of shortening the length of scale in this region.

Thus the requisite impedance has been determined as a nest of 13 tubes each of diameter 0·34 cm. This is by no means an impracticable requirement, although careful design would be necessary to ensure approximately equal flow rates through each of the 13 members of the honeycomb. In view of this, and of the fact that certain factors have been neglected in the course of the calculation, the viscometer would need to be calibrated empirically using a selected number of fluids having viscosities reasonably evenly distributed over the range 2–10 cp,

A similar calculation can be made to give an alternative solution which would be easier to construct, and quite practicable when a large float is available; in this case $\frac{l}{H}$ being set at the value 15, the requisite impedance is determined as six parallel tubes each 0·73 cm. in diameter. The tubes would require to be at least 200 cm. long to sufficiently reduce the influence of the factor $\frac{q\rho}{16 \pi l}$, but a length of 300 cm. would ensure a more positive driving head, viz. $H = \frac{l}{15} = \frac{300}{15}$ = 20 cm. In large installations these comparatively long lengths of tubing could be made into coils.

It has already been mentioned that the range of Rotameter-adapted constant-head viscometers would necessarily be limited, but they might nevertheless well find uses in chemical industry in the control of processes in which viscosity is a sensitive indication of chemical composition. In such cases low viscosity ranges are often involved, as opposed to oil-refinery requirements where the viscosities involved are usually in excess of 100 cp.: furthermore, within this low range of viscosities the flow-rate capacities of the relevant Rotameters are not excessive for 100 per cent. inspection purposes, or even for sampling purposes in many industrial processes.

However, it is of interest to notice how acutely the design of the viscometer depends on the limitations of the flowmeter, as is shown in a re-examination of the above example on the basis of assuming the possibility of viscous independent flow-rate readings for all viscosities less than 50 cp. (instead of 10 cp. as in worked example). Here, for the same sampling rate as before, calculation shows the possibility of measuring over the range 10–50 cp. with a laminar impedance comprising one tube only (of diameter 1·04 cm.) working at much safer Reynolds numbers (consistent with $r = 1{,}700$ when $\eta = 10$ cp.) and with a rather more convenient value for the ratio $\frac{l}{H}$, i.e., $\frac{l}{H} = 2$. This viscosity range is of course of much more general application than the range 2–10 cp. previously considered. Also, this latter example is interesting in itself, since it probably does not call for requirements which are entirely outside the possibilities of advanced designs; since by attention to the design of the float, the readings of such instruments are rendered viscous independent over a much larger range than with conventional instruments.

Generally, in this application, the use of Rotameters would be restricted to cases where fluid density is tolerably constant, since readings of such instruments are density dependent. However, changes in density produce much less

* The form of this equation is similar to that of (8) when re-arranged to give η as the dependant variable. However, should the laminar-flow impedance be followed by a length L of main of diameter D, η is given by the modified expression

$$\eta = \frac{1}{m^2 N^2} \frac{d^4 g H \rho \pi}{128 q l} - m^2 N^2 \frac{\rho q}{16 \pi l \eta} \left(1 + \frac{\lambda L}{D}\right),$$

where $m = \frac{d^2}{D^2}$.

than proportionate changes in flow-rate readings due to the density factor entering the meter characteristic equation (flow-rate versus float-lift) under the square-root sign.

Constant-head viscometry on an industrial scale will undoubtedly be greatly facilitated by use of electromagnetic flowmeters. Recently, such instruments suitable for industrial use have become commercially available, e.g., the Tobiflux meter by Tobi N.W., Amsterdam, Holland. These instruments—which were originally developed by Kolin[2]—operate by measuring the minute electromotive force generated by a fluid stream when flowing in (and across) the field of a strong electromagnet. If this e.m.f. is measured at a suitable electrical impedance it is possible to obtain readings which are independent of the electrical conductivity of the fluid over quite large conductivity range, but what is of more significance, from a mechanical point of view, is that the measured e.m.f. is proportional to the true mean velocity over the cross section of the pipe, irrespective of the velocity profile or the viscosity coefficient. Moreover, the instruments are capable of measuring very small fluid velocities in, if necessary, very small pipes (in which the flow is entirely laminar) and could quite easily be adapted to low flow-rate capacity floating-syphon samplers used as described above for the determination of fluid viscosity.

The author wishes to thank the director of the British Scientific Instrument Research Association for permission to publish this material; Mr. M. Rainer for reading through a draft of the paper; and Mr. E. F. Knight, who gave considerable assistance in the construction and calibration of prototype and demonstration instruments.

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[1] F. C. Johansen, "Flow through Pipe Orifices at Low Reynolds Numbers." *Aeronautical Research Committee*, Reports and Memoranda, No. 1252 (1929).

These data refer to small pipe-orifices with appreciable lengths of straight main both upstream and downstream of the orifice position. The assumption that the coefficients apply to the end-cap position, and that data for an orifice/main area-ratio of 0·04 apply to smaller area-ratios, implies that calculations based on these data in the application discussed in this article are necessarily approximate.

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The Engineering Outlook—11

LIGHT ELECTRICAL AND CABLE INDUSTRIES

PROSPECTS BRIGHT IN SPITE OF CREDIT SQUEEZE

The light electrical industry has been one of the first to feel the onset of the credit squeeze. Since so much of its production is of consumer durable goods, it is bound to react quickly to the purchasing habits of the general public. This rapid reflection of the state of the public's spending accounted for the boom in 1954 and the good trading conditions in the first half of 1955. It likewise accounted for the less favourable trading conditions in the second half of 1955 and in the early months of 1956. In the long run, however, the prospects are bright. Provided this country's immediate economic troubles can be surmounted, the long-term rise in the standard of living should continue, and this will bring with it increased purchasing power and a rising demand for labour saving devices in the home.

In complete contrast to the light electrical industry, the cable industry has enjoyed much better trading conditions over the last 12 months than seemed likely in the early months of 1955. Despite rising costs, and especially the volatility of copper prices, both the heavy and the light sections of the cable industry have been able to report better home sales and higher exports. To take only one case of this, in April the annual report of British Insulated Callender's Cables, Limited, showed an increase of £4·47 million (60 per cent.) in its group trading profits for 1955—a total of £11·85 million.

In the light electrical industry, the excellent trading conditions in the earlier months of 1955 were counterbalanced by comparatively poor results in the later months. In consequence, as can be seen from the graphs given in Fig. 1 and Fig 2, the outcome for the year in terms of volume of output was very similar to 1954 in most categories. The long-term forces at work, however, on the demand for television sets were sufficient temporarily to offset the earlier phase of the fall in demand, and the output of these sets increased by 42 per cent. on the year. Fig. 3 shows that electric cookers were the earliest casualty following the reimposition of additional hire purchase restrictions in the middle of the year. With a decline in output of 18 per cent., they were the only category of consumer durable goods (for which official statistics are available) to record an actual decline. In the case of refrigerating machinery, there was a noticeable drop in output of domestic types after October and, although the year 1955 showed a slight increase on 1954, output in January, 1956, was 15 per cent. lower than in January, 1955. Experience has, however, been somewhat uneven within the industry. As would be expected, the output of industrial refrigeration machinery was not severely affected by the credit squeeze. The graph in Fig. 4 shows there was a decline of 3 per cent. in production between 1954 and 1955, but the figure for January, 1956, is slightly higher than that for January, 1955.

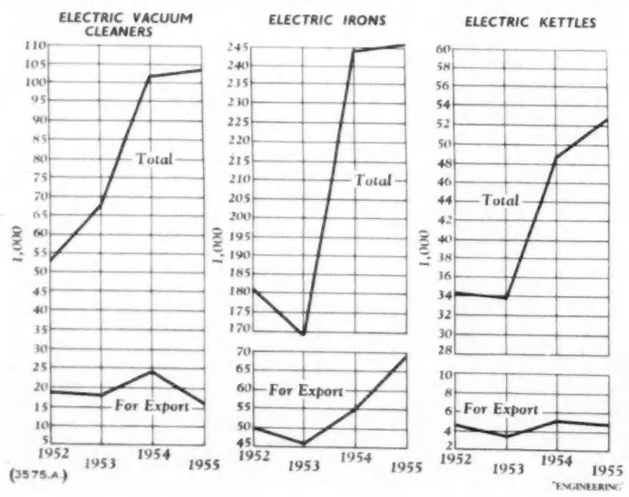

Fig. 1 Domestic electrical appliances made in the United Kingdom from 1952 to 1955 (monthly averages).

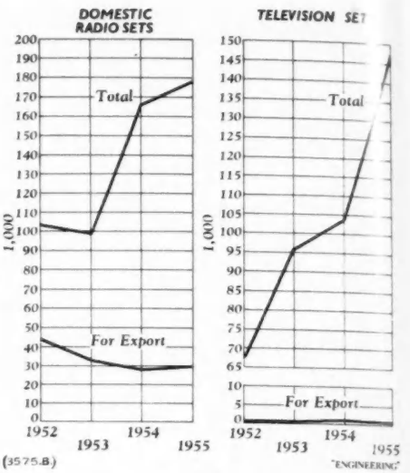

Fig. 2 Radio and television sets (monthly averages).

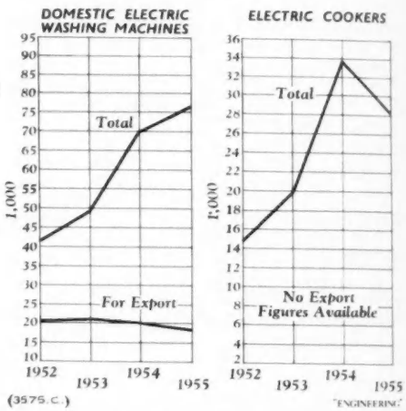

Fig. 3 Domestic electric washing machines and cookers (monthly averages).

NO IMMEDIATE FALL

There was a tendency at the beginning of this year to assume that the credit squeeze would bring a severe drop in the sales of electrical goods to the public because there were signs that stocks of both motor cars and television sets were piling up. This may have occurred to some extent, but such statistical evidence as there is for the first two months of 1956 suggests that the credit squeeze operated fairly slowly on the public's purchase of light electrical equipment up to that time. The Board of Trade's index of retail sales of hardware, radio and electrical goods (base year 1950, equal to 100) stood at 135 in January of this year compared with 131 in January, 1955. It was running therefore

United Kingdom Exports of Light Electrical Goods and Apparatus

—	Value (£1,000)		
	1953	1954	1955
apparatus:			
stic radio receivers	3,513	3,176	3,479
ision receiving sets	428	450	492
mitting apparatus	11,049	12,397	12,846
, complete	2,200	2,111	2,551
ones and telegraph ratus	16,581	15,133	15,821
Electric light bulbs, complete	1,085	1,290	1,481
Electric light apparatus and appliances	4,886	4,714	5,110
Batteries, primary, complete	2,251	3,100	3,479
Accumulators, complete	3,107	3,195	3,346
Electrical cooking and heating appliances	2,704	3,912	4,971
Electrical instruments	3,496	4,355	4,751
Electro-medical apparatus	1,221	1,113	1,372
Refrigerating machines	12,882	15,262	14,484
Vacuum cleaners, complete	1,500	2,030	1,575
Total	66,903	72,238	75,758

slightly higher than at the same time a year earlier and was 64 per cent. of the level achieved in December, 1955. This heavy drop in January was, of course, seasonal. The first set of hire purchase statistics to be put out by the Board of Trade were published last month, and showed the index number of hire purchase sales of hardware, radio and electrical goods in the shops at 62 for January, 1956, with December, 1955, as 100. In February, 1956, the hire purchase index moved up to 65 while the index of total sales the year before (February, 1955) actually fell. It is not possible to read into such figures a severe fall in turnover apart from seasonal influences. It may be that the continuation of credit restrictions, or even increased impositions if the present restrictions are not adequate, will prevent a seasonal recovery through March and April. The general impression, however, from the statistics is that the restrictions imposed in the Autumn Budget were beginning to wear off slightly by February.

It remains to be seen whether the further restrictions on hire purchase imposed in February, 1956, will seriously affect the output of domestic electrical appliances in the months to come. So far as radio and television sets are concerned, there is certainly evidence that sales took a turn for the worse in March. It was estimated in that month that the retail sales of television sets would fall this year by about 20 per cent. below the 1955 level, and that about 400,000 sets in stock at January had remained to be cleared, a figure three times as high as in January, 1955. Unskilled labour and part-time workers were being shed, although the big companies were, and still are, reluctant to disturb the hard core of skilled workers. It may be that the decision in February to restrict the facilities which radio and television rental companies could offer will have a serious effect from now on, for one consequence of the restriction of hire purchase facilities had been to increase the popularity of rental agreements.

Exports indicate that in contrast to the complex and disappointing outlook in the domestic market the export of light electrical goods continues at a satisfactory level. Table I shows that there was a useful increase in the value of exports in 1955 and since the turn of the year business has continued good in foreign markets. The manufacturers most likely to gain from this feature are those making radio transmitting apparatus and television equipment. Unfortunately, the export of such goods as complete television sets is as yet small, and those concerns which are not diversified and have to rely on selling a line of completely assembled radio and television equipment for the general public is mainly dependent on the home market for its sales.

WIDENING RADIO FIELD

The outlook for telecommunications equipment of all kinds continues to be good both in the home and export markets. In the home market the General Post Office has been able to increase its orders for equipment over the last year. Technical progress in broadcasting has been steady if somewhat unspectacular. There is some prospect that opening of high-frequency frequency-modulated stations to cover areas in North East England, Northern Ireland and North East Scotland will bring added turnover not only for transmission equipment but also for new sets. In television, there are three long-term factors at work which make prospects for the equipment manufacturers eventually good in spite of the credit squeeze. It is becoming apparent that colour television will be a commercial proposition probably well within a decade, and that before very long the manufacturers will be actively engaged producing sets which will be able to reproduce both the present monochrome type of pictures and also colour television. Secondly, the extension of commercial television beyond the London area will be a stimulus to the industry both for transmission equipment and for receiving sets. Thirdly, further modifications in standard television sets will probably be necessary as and when the B.B.C. introduces its second television programme. Some of the frequencies may have to be in Band IV. If the B.B.C. is allotted frequencies in Band III it expects to start its second programme in two or three years, but in due course Band IV will have to be used as well, say in about five years time, and this will involve new tuning equipment on sets. It is highly possible that the adjustments for colour television will be occurring at the same time as the development of the B.B.C.'s alternative programme and this technical activity should result in increased turnover for manufacturers.

The problem of the future of the transistor continues to add to the stimulating technical ferment in the radio industry. It is only eight years since the transistor first made its appearance and the question since that time has been how far it would replace the thermionic valve. Progress with the transistor has been somewhat slower than some of the optimists had expected. So great is the expansion in the electronics industry at present that both are extending their uses. The transistor's advantages have been apparent from the start. It is very small and it consumes very little power and creates little heat. Its range of high tension voltages may be as low as 1 to 12 volts and it is certainly robust. On the other hand it does not yet operate at very high frequencies and germanium transistors cannot at present be used at above 115 deg. F., which is a drawback for military equipment. It remains to be seen if silicon transistors can meet this deficiency. In television receivers it is already apparent that transistors will become complementary to valves. The development of power

Fig. 4 Production of different types of refrigerators in the United Kingdom since 1952 (monthly averages).

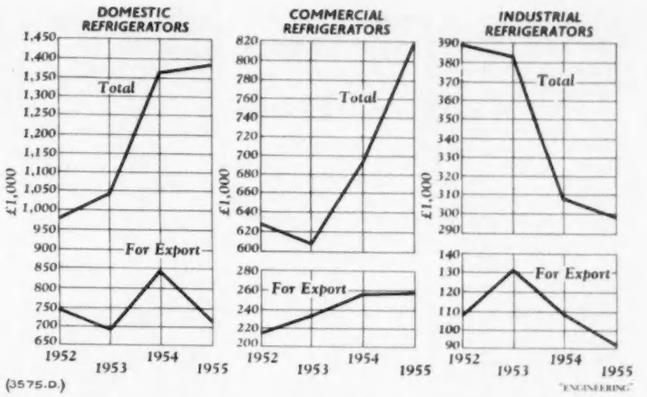

TABLE II. United Kingdom Exports of Electrical Wires and Cables.

—	Quantity (Tons)			Value (£1,000)		
	1953	1954	1955	1953	1954	1955
To Nigeria	1,596	956	1,672	469	279	548
,, Union of South Africa	7,366	3,949	2,831	2,677	1,387	1,062
,, Rhodesia and Nyasaland	2,365	1,239	2,977	677	378	809
,, Kenya	1,253	1,064	660	404	255	253
,, Kuwait	1,343	1,473	1,717	432	398	409
,, India	17,466	10,885	14,067	5,041	2,705	3,927
,, Pakistan	2,497	3,956	3,228	720	1,087	864
,, Singapore	2,709	4,093	3,534	791	834	1,003
,, Federation of Malaya	1,948	1,960	2,666	580	571	768
,, Ceylon	1,525	550	537	432	200	223
,, Hong Kong	1,751	1,526	2,675	582	451	800
,, Australia	7,837	4,713	4,881	2,301	1,389	1,711
,, New Zealand	8,063	5,698	8,570	2,427	1,610	2,501
,, Canada	2,999	1,482	1,660	713	429	499
,, Trinidad	482	399	574	169	143	213
,, Other Commonwealth countries	11,360	7,664	7,317	3,209	2,169	2,440
,, Irish Republic	1,394	1,090	813	499	393	339
,, Norway	1,164	483	734	285	126	156
,, Denmark	134	374	612	81	166	179
,, Netherlands	341	596	739	150	246	356
,, Portugal	572	889	645	200	273	234
,, Austria	179	533	943	49	136	237
,, Greece	417	554	1,640	134	184	569
,, Roumania	3,387	143	—	1,056	39	—
,, Turkey	1,183	179	1,115	360	48	309
,, Israel	669	280	116	220	35	51
,, Iraq	2,618	1,345	1,289	703	355	378
,, Burma	629	954	986	226	297	276
,, Colombia	307	1,685	715	108	439	207
,, Venezuela	1,121	1,498	1,911	382	463	571
,, Other Foreign countries	12,707	6,234	22,064	3,554	1,906	5,858
Total	99,382	68,444	93,888	29,631	19,390	27,751
Telegraph and telephone cables and wires:						
Submarine	4,887	4,749	4,321	921	771	862
Other	26,284	13,906	23,788	7,882	3,796	6,393
Other Descriptions:						
Cotton, silk or artificial silk insulated	1,306	889	1,057	665	439	591
Enamel, glass or asbestos insulated	1,576	1,670	1,612	976	874	930
Paper insulated	45,928	28,049	41,198	11,060	6,128	9,718
Rubber insulated	12,977	13,470	15,220	5,005	4,646	5,746
Thermoplastic insulated*	—	—	2,025	—	—	1,044
Other	6,424	5,711	4,667	3,122	2,736	2,467
Total	99,382	68,444	93,888	29,631	19,390	27,751

* Not separately distinguished prior to 1955.

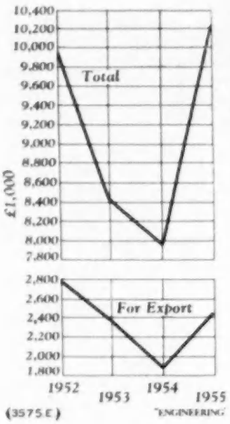

Fig. 5 Electric wires and cables made in the United Kingdom since 1952 (monthly averages).

transistors will open up a wide field of uses in amplification systems.

In the export market the outlook for radio, television and communications equipment continues to be good. Prices are keen but the quality of British equipment has already won it goodwill in many markets. Decca Radar has now been ordered for one-fifth of the world's total registered tonnage, that is, for over 20 million gross tons of shipping. Marconi have now sold more route miles of very high frequency multi-channel communications gear on the international market than any other manufacturer. The postal and telegraph services of over 80 countries outside the British Isles use this company's telecommunications equipment. The same company has had orders for television transmitters for the new Australian services, the first three Danish stations and orders from Italy and Canada as well. In the Australian market Electrical and Musical Industries, Limited has been active of late. In sound broadcasting, Pye has recently made further progress with its exports and this company is thought to have accounted for about one-third of sound broadcasting receivers exported in 1955. Good business has been done by Pye with radio and television equipment in the Far East and Africa. Standard Telephones and Cables and G.E.C. have done considerable business abroad in short-range radio transmitter-receivers which are made to carry either sound or vision signals and can also be used for ordinary communications.

A branch of the export trade which is beginning to assume significance is sound reproduction equipment. This consists mainly of record changers, pick-ups, microphones, loud speakers and a fairly wide range of radio components. The U.S. market has been particularly encouraging. An opening has been found there for high quality products which do not compete with the American mass-produced article. The continuing growth of the radio components section is in fact one of the outstanding features of the light electrical industry at present. It has been estimated that in the first half of 1955 there were 175 companies registered as radio component manufacturers. Some of these are comparative newcomers to the industry and altogether the output from this group is probably running at over £50 million a year.

MORE CABLES WILL BE NEEDED

In spite of a number of serious obstacles, the cable manufacturing industry had a much better year in 1955 than might have been expected. In varying degrees both the heavy and the light cable manufacturers have had to contend with rising prices of copper and rubber, the dislocation following the undertaking by the industry to carry out the substance of the Monopoly Commission's report, and continued fierce competition in foreign markets. Since the industry as a whole works on a comparatively short order book, it is more subject than at first might appear to fluctuations in sales. There is no doubt that 1955 saw a turn for the better and despite continuing concern about costs, the outlook continues to be good. During 1955, the Central Electricity Authority and the National Coal Board resumed normal buying after a period of working through stocks. The General Post Office also placed a number of useful orders and these, supported by the generally good conditions in British industry last year, were sufficient to bring a recovery in home demand. The makers of heavy cables are now beginning to benefit as well from the growth of the television industry and this benefit should increase as the transmission networks become more widespread and colour begins to be broadcast as well as monochrome. Another factor now developing which will benefit the cable manufacturers is the electrification programme of British Railways. The recent cuts in the British Transport Commission's capital development programme will not affect progress with this scheme, and benefit from this source should begin to accrue to cable manufacturers before the end of 1956. Since the National Coal Board and the Central Electricity Authority are both committed to a continuing heavy capital investment programme there is every prospect that the home market will continue to produce a satisfactory amount of business. The ship-building industry, too, should provide an increasing amount of work since it faces boom conditions in the next two years.

Export business continues to be good. In Table II the total value of electric wire and cable exports is shown to have increased from £19·4 million to £27·8 between 1954 and 1955, that is, by just over 43 per cent. Even at this level, however, they were still about £2 million below the level achieved in 1953. The bulk of the recovery occurred in Commonwealth markets, the only disappointing feature being exports to Canada. Several of the large companies, however, have reported orders from North America in the last 12 months. W. I. Henley's Telegraph Works, Limited, obtained business in Canada and the United States last year and B.I.C.C. have already obtained two large orders in 1956, one in Ceylon and the other in Canada. This last company is now investigating the possibility of a power link-up between South and North Islands in New Zealand. It should be noted that the export of rubber-insulated cables, which declined in 1954 rather less than total cable exports, showed a comparatively smaller increase in 1955, at 24 per cent. This recovery nevertheless put rubber-insulated cable exports in 1955, at a higher level than in 1953. The improved performance of the cable industry in export markets has thus not been confined to the heavy end of the trade. There will always be fierce competition among cable manufacturers in foreign markets, and comparatively newly industrialised countries will be as anxious in the future as they have been in the past to establish a local light cable industry. In consequence, the British industry's recent performance is noteworthy. Over the industry's markets as a whole there is every prospect of expanding turnover even though there may be short-term set-backs. The general increase in industrial potential throughout the world accompanied by the increased use of electronics and telecommunication systems of various kinds, must mean a growing demand for cable and wire. The fact that the British cable industry is operating alongside radio and telecommunication industries of proven technical ability means that they should be able to supply equipment of outstanding technical quality. For the rest, it is a matter of price.

HIGH-FREQUENCY HEATING IN SOLDERING AND BRAZING

EXAMPLES OF INDUSTRIAL APPLICATIONS

The reproduction on the front cover of ENGINEERING a few months ago of a photograph showing high-frequency heating being used for a brazing operation in laboratory work aroused considerable interest although the process is by no means new, being extensively employed in modern industry. High-frequency heating has many advantages of which cleanliness, safety, rapidity, reliability and effectiveness are the most obvious, but as these advantages are perhaps not as widely appreciated as they might be we give below a few typical examples of soldering and brazing operations effected by high-frequency heating.

NO SKILL REQUIRED

In this process the articles to be joined are placed in the magnetic field produced by a heating inductor carrying a high-frequency current. Eddy currents are set up in the metal parts by the rapidly alternating magnetic flux and the heat produced by these eddy currents is sufficient to raise the metal parts to a temperature suitable for soft soldering, silver soldering or brazing. The solder or brazing spelter, together with the necessary flux, is thus melted and runs into the joint. The heating times are short, ranging from a few seconds to a minute or so, depending on the size of the parts to be joined and the power of the high-frequency generator employed, which consists either of a thermionic valve and an oscillating circuit or a high-frequency motor-generator and associated equipment. The frequencies used vary between

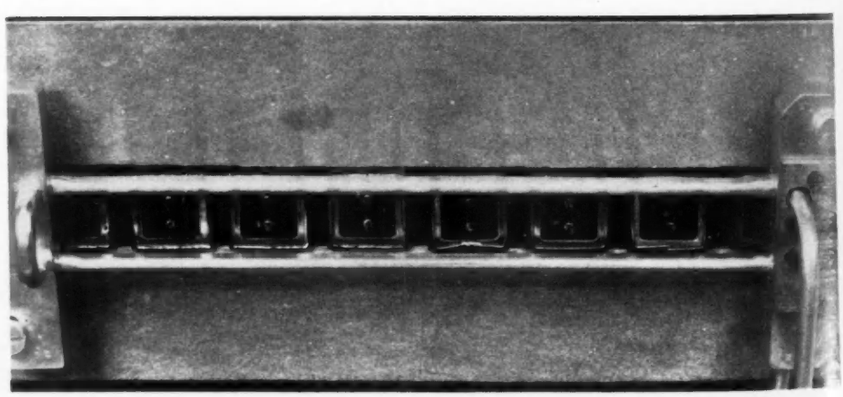

Fig. 1 Soft soldering lids on capacitor cans. The advantages of high-frequency heating inclu cleanliness, safety, rapidity, reliability, effectiveness and the confinement of heating to a limited regio

Fig. 2 Silver soldering parts of thermostats in jigs, each of which holds ten units. The process is semi-automatic and the jigs are spring-loaded.

2,000 and 10,000 cycles per second in the case of motor-generator equipment and 300 and 3,000 kilocycles per second for valve-oscillator equipment. As the parts to be joined can be located precisely with respect to the magnetic flux and the high-frequency current, and process time can be regulated closely, the results obtained can be repeated indefinitely, without relying on any special skill on the part of the operator. For uniformity, the solder is usually applied in the form of wire or foil cut to the correct length or shape so that sufficient is available to make the joint without any surplus. In some cases it may be advisable, when changing over to high-frequency heating, slightly to modify the design of one or both of the parts to be joined so that the exact amount of solder required can be placed conveniently in, or in proximity to, the joint. A close mechanical joint is desirable, as this will result in a better joint and economy in brazing material.

SOFT SOLDERING

A typical example of the application of high-frequency heating in soft soldering is illustrated in Fig. 1, in which lids are being soldered on to capacitor cans. The illustration is a plan view of the installation and the cans are being traversed on a conveyor at a steady speed from right to left past the heating coil, which in this case takes the form of two parallel water-cooled tubes. On the cans shown on the right the solder can be seen in the form of a wire bent into a rectangular shape. By the time the can has reached the centre of the inductor the solder can be seen to have started to melt and at the left-hand end of the coil the joint is complete. In this case the design of the can was slightly modified when converting to high-frequency heating so as to bring the walls of the can just above the level of the lid, thus keeping the solder in the correct position.

SEMI-AUTOMATIC PROCESS

A good example of a semi-automatic process is afforded by Fig. 2 which shows the silver soldering of thermostat assemblies ten at a time. The operators in the background are assembling the thermostats on a specially designed spring-loaded jig which is passed to the operator in the foreground who clamps it on to the vertical and horizontal bars on the front of the high-frequency generator. The inductor, which passes round the lower part of the jig, is connected to the terminals of the generator and the passage of the high-frequency current heats the parts sufficiently to cause the solder to run. The jig is then removed from the generator and passed to one of the operators on the right for the thermostats to be dismounted.

SPECIAL JIGS

An interesting application of a different type is illustrated in Fig. 3 which shows the equipment used for silver soldering metal wire loops on to the backs of brass blazer buttons. For this purpose ingeniously designed jigs, four of which can be seen in the illustration, are employed. Each jig holds two buttons and the operator, holding the jig in her left hand, slips the loops into slots which hold them in contact with the backs of the button blanks. The solder and flux are applied in the form of a paste and the jig is then slipped on to two pins projecting from the working table. In the illustration the position in which the freshly loaded jig will be placed is occupied by another jig waiting to be removed. Spring clips, one of which can be seen on this jig, make contact with the terminals of the generator and convey high-frequency current to small coils surrounding the blanks which are heated to the melting point of the solder by the passage of the current, without heating the jig unduly. The heating time, which is automatically controlled, is 4½ seconds and the buttons, with the loops attached, are released from the jig by pressure on the sides.

FOR LARGE-SCALE PRODUCTION

As will be appreciated from the examples given, high-frequency brazing and soldering are generally applied to large-scale production where runs of some hours are usual and appropriately shaped coils and suitably designed jigs can be employed. For work of this class its applications are widespread. Fig. 4 shows a corner in the works of a manufacturer of gas meters where eight installations of different types, both automatic and semi-automatic, are in use. This illustration also shows that the installations can be incorporated in a production line without affecting the safety or comfort of the personnel.

In all the applications illustrated high-frequency heating offers distinct advantages over methods previously employed. The heat is located precisely in the area of the desired joint, and the heating of other parts avoided. Less restricted heating could have adverse effects on the complete components. Moreover, the apparatus used is intrinsically safe for operation by unskilled personnel.

We are indebted for the information and illustrations used in this article to the Industrial High-Frequency Heating Equipment Section of the B.E.A.M.A., 36 Kingsway, London, W.C.2.

g. 3 Silver soldering wire loops to backs of brass blazer buttons. Ingenious jigs are used, four of which can be seen.

Fig. 4 High-frequency soldering equipment on production lines in a gas-meter factory. There are eight different kinds of installations.

NEW BOOKS

Some of the books noticed here are selected for extended review in ENGINEERING.

Regulation of Radiation Exposure by Legislative Means. National Bureau of Standards Handbook 61. *The Superintendent of Documents, U.S. Government Printing Office, Washington* 25, *D.C., U.S.A.* (25 cents.)

This handbook, unlike the recommendations which have been made in the past by the National Committee on Radiation Protection, deals not with technical fields but with the problem of radiation in relation to its possible control by State or municipal authorities. Contrary to its former practice, the Committee has now adopted the policy of neither recommending nor opposing the incorporation of its findings into State codes. This book is, however, intended to provide assistance to those who propose to adopt regulations for such work in the hope that thereby uniformity will be secured. The need for the control of radiation exposure is discussed, as are the rival claims of licensing and registration, advisory service and the formulation of State liquidation. A draft Act and regulations are included.

The Electricity Supply Industry in Europe. *Organisation for European Economic Co-operation, 2 Rue André-Pascal, Paris* 16. (500 francs); and *H.M. Stationery Office, Kingsway, London, W.C.*2. (10*s.*)

This report on the position of the European electricity supply industry is the second to be published by the Electricity Committee of the Organisation for European Economic Co-operation. It analyses the recent trend of that industry and gives some estimates of its development up to 1960. The statistical information used in preparing the report was supplied by the countries themselves and is reproduced in a series of tables dealing with installed capacity, available peak capacity production and fuel consumption. Consumption in the member countries increased from 300,000 million kWh in 1953 to 328,000 million kWh in 1954, or by 9·3 per cent. It is expected that this trend will continue. Rather more thermal than water power plant is being installed and its efficiency is increasing.

Rules and Regulations for the Construction and Classification of Steel Ships, 1955. *Lloyd's Register of Shipping, 71 Fenchurch-street, London, E.C.*3. (42*s.*)

Certain modifications and rearrangements are incorporated in this edition. The present requirements for welded construction of steel ships, previously contained in Sections 31 and 33, and in Section 34, have been revised and embodied in a new Section 31. The requirements for riveted construction, previously contained in Sections 32 and 34, have been collected and rearranged in Section 32. Rules have been adopted for ships specially designed for the carriage of ore cargoes.

Guide to Instrumentation Literature. By W. G. BROMBACHER, JULIAN F. SMITH and LYMAN M. VAN DER PYL. National Bureau of Standards Circular 567. *The Superintendent of Documents, U.S. Government Printing Office, Washington* 25, *D.C., U.S.A.* (1 dol.)

This publication consists of an introduction, a source list of instrumentation literature, an author index and a subject index. Over 1,200 references are listed, including abstract journals, bibliographies, books on technology, directories of manufacturers, guides to and indexes of technical literature, periodicals of interest, and guides to dissertations, patents and specifications. Articles published in periodicals are not referenced, but indexes and abstracts of such articles on a given subject are indicated in the subject index.

Symposium on Role of Models in the Evolution of Hydraulic Structures and Movement of Sediment, 1952. Publication No. 53 of the Central Board of Irrigation and Power. *The Manager of Publications, Government of India, Delhi.* (No price given.)

During the last decade much use has been made in India of model experiments before attempting to design hydraulic structures and river control works. The protection of existing structures has also been examined by making preliminary tests on hydraulic models before proceeding with site work. The symposium, which is the subject of the present report, was organised to bring together the lessons that have accrued from the many researches made by the various departments of the Central Board of Irrigation and Power. Simultaneously, the opportunity was taken to review present knowledge of the behaviour of sediment in streams, canals and reservoirs. The publication contains 15 papers on the first subject and five on the second, together with verbatim reports of the ensuing discussions on each.

Symposium on Determination of Costs and Benefits of River Valley Projects, 1953. Publication No. 54 of the Central Board of Irrigation and Power. *The Manager of Publications, Government of India, Delhi.* (No price given.)

In October, 1953, the Central Board of Irrigation and Power in India organised a symposium to examine a variety of problems related to river valley projects, and the 17 papers and the discussion thereon are now published in book form. Among the topics dealt with were the various factors contributing to costs and to the revenues both direct and indirect that could ultimately be obtained from the schemes. The papers are related both to specific projects that are complete or are under way, as well as to hypothetical schemes designed to illustrate the points under discussion.

Tables of Thermal Properties of Gases. National Bureau of Standards Circular 564. *The Superintendent of Documents, U.S. Government Printing Office, Washington* 25, *D.C., U.S.A.* (3.75 dols.)

Progress in all fields of science and technology depends on a knowledge of the properties of matter. The study of high-speed flight rests particularly on precise information concerning the physical characteristics of fuels and oxidisers and of the atmosphere in which flight takes place. This collection of tables, which is one of a series published by the National Bureau of Standards, provides the basic thermodynamic and transport data for air and its constituents and other gases, relating to aerodynamic research. The tables are not, however, restricted to aircraft work and may be used generally where knowledge of the properties of the following gases is required: hydrogen, argon, carbon dioxide, carbon monoxide, nitrogen, oxygen and steam. The tables have been compiled by a large number of contributors with the aid of S.E.A.C. (Bureau of Standards Eastern Automatic Computer) and graphs and explanations are provided where convenient. Tables of conversion factors and a comprehensive contents list are included.

Materials for Nuclear Power Reactors. By HENRY H. HAUSNER and STANLEY B. ROBOFF. *Reinhold Publishing Corporation, 430 Park-avenue, New York* 22, *N.Y., U.S.A.* (3.50 dols.); and *Chapman and Hall, Limited, 37 Essex-street, London, W.C.*2. (28*s.*)

One of the series of Reinhold Pilot Books, this pocket-size introduction to the choice of materials for nuclear reactors includes sections on the basic design of various kinds of reactor, nuclear fuels, moderators and reflectors, coolants, control elements, shielding, construction material and special problems of radiation. There is also a table of thermal neutron cross-sections for the elements and certain isotopes, and a glossary. The authors of the book, which contains an index, are both managers in the Atomic Energy Division of Sylvania Electric Products Incorporated.

The Protection of Workers against Ionising Radiations. Report submitted to the International Conference on the Peaceful Uses of Atomic Energy, Geneva, August, 1955. *International Labour Office, Geneva, Switzerland.* (3*s.*)

The topics dealt with in this publication include: types of injury caused by ionising radiations, standards of exposure, the uses of ionising radiations, protective measures and special precautions, problems arising in uranium mining and processing, and the safe transport of radioactive materials. There are also appendices giving a model code of safety regulations, permissible weekly doses for the critical organs, examples of medical record forms, United Kingdom deliveries of radioactive isotopes, and recommendations for the prevention and suppression of dust in mining, tunnelling and quarrying. It should be noted that the report is intended as a survey solely of the factors concerned in worker protection and ignores aspects of concern to public health authorities. One, of the contributors to the report, which is illustrated, was Mr. K. L. Goodall, F.Inst.P., H.M. Chemical Inspector of Factories.

Industrial Birmingham. Publication 119. **Birmingham, Britain's Second City.** Publication 125. *City of Birmingham Information Department, Council House, Birmingham,* 3. (1*s.* each.)

These two booklets are complementary. The first gives a sketch of the industrial history of Birmingham, and of some of the well-known trades carried on in the City. Nothing more than a sketch is possible; the number of trades in Birmingham runs into over 1,200, but the booklet gives an overall picture of a range, from pens to rolling stock, from sporting guns to motor vehicles, and from fine jewellery to large air compressors, which it would be difficult to equal. The second booklet provides information for the intending visitor or resident; accommodation, amenities, services provided by the Council, general information, are all summarised.

Copper Wire Tables. National Bureau of Standards Circular 31. 4th edition. *The Superintendent of Documents, U.S. Government Printing Office, Washington* 25, *D.C., U.S.A.* (30 cents.)

This is the fourth edition of a circular which was first issued in 1912, at the request of the Standards Committee of the American Institute of Electrical Engineers. The tables are based on the American Wire Gage, the diameters being rounded to the nearest tenth mil and are then calculated as if these rounded diameters were correct. Some of the original material, including matter of an historical character and the tables for aluminium wire have been omitted. On the other hand, the tables have been extended to No. 50 gauge and to 200 deg. C. In addition to the tables considerable explanatory matter is also included.

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given though distribution is sometimes restricted.

Safe Operation of Bar Reeling and Straightening Machines. BRITISH IRON AND STEEL FEDERATION, Steel House, Tothill-street, London, S.W.1. Investigation of problem of safe operation of bar reeling and straightening machines. Several effective safeguards reviewed. Results of investigation summarised and recommendations for safety of operator given. Illustrated 32 page booklet.

Selecting Industrial Trucks. YALE & TOWNE MANUFACTURING CO., British Materials Handling Division, Wolverhampton, Staffordshire. Booklet, "How to select industrial trucks," describes types of equipment and their uses; operation, manual or power; types of power operation; type of industry involved; and actual applications of truck.

Geared Motors and Speed Reducers. ELECTROPOWER GEARS LTD., Kingsbury Works, Kingsbury-road, London, N.W.9. Standard helical spur reducers combined together forming an integral unit. Extremely slow speeds at high efficiency; available as separate speed reducers with high and low-speed shafts or as complete motorised units. Illustrated specification leaflet.

"The Simms Story." SIMMS MOTOR UNITS LTD., Oak-lane, East Finchley, London, N.2. Commemoration volume describing the growth and progress of the firm from 1891 to the present day. Profusely illustrated with pictures of early vehicles and modern internal-combustion engine equipment.

Miniature Lighting Plant. MAX ARC AND ELECTRICS LTD., Terrace-road, Walton-on-Thames, Surrey. Four-stroke, air-cooled petrol engine of 98 cub. cm. capacity driving 400 watt alternator built into flywheel. Output at 25, 110 or 230 volts. Illustrated leaflet.

Petroleum Activities. THE BRITISH PETROLEUM CO. LTD., Britannic House, Finsbury Circus, London, E.C.2. Photographs and text illustrating some of the activities of the British Petroleum Company Ltd., and its associated companies in 1955. Brochure.

Cutting and Metalworking Oils. C. C. WAKEFIELD & CO. LTD., 46 Grosvenor-street, London, W.1. History and fundamentals of metal cutting and the selection of suitable oils for each operation. Range of oils available and their properties. Illustrated booklet.

Sensitive Bench Drill. STARTRITE ENGINEERING CO. LTD., Waterside Works, Gads Hill, Gillingham, Kent. "Bantam," ½ in. capacity sensitive bench drill. Electrically driven, with or without automatic air hydraulic power feed. Four-speed belt drive. Illustrated leaflet.

Irrigation Pumps. PEGSON LTD., Coalville, Leicestershire. Flood-type irrigation pumps with capacities from 44,000 to 220,000 gallons per hour. Efficiencies over 80 per cent. Total heads up to 35 ft. Illustrated specification leaflet.

Shearer-Loader. BRITISH JEFFREY-DIAMOND LTD., Wakefield. The B.J.D.-Anderton Shearer loader for thick seams. Ranging head gives choice of heights from 4 ft. 7 in. to 7 ft. 3 in. Three drum sizes. Leaflet No. 1517.

Electrical Control Instruments. SERVOMEX CONTROLS LTD., Crowborough Hill, Jarvis Brook, Sussex. A.C. voltage stabilizers up to 30 amp. output, electronic motor controllers, d.c. power supplies and other instrument. Illustrated catalogues.

ook Reviews

MAKING FULL USE OF TIMBER

ninated Timber. Project No. 113. *Organisation for European Economic Co-operation, 2 Rue André-Pascal, Paris 16, France.* (500 *francs*); and *H.M. Stationery Office, Kingsway, London, W.C.2.* (10*s.*)

The technique of laminating wood—gluing strips of boards together to form a built-up component—has been used for many years in making furniture, parts of pianos, sports goods and other products, but its application to buildings and other structures is a development which only began in Europe just before the first world war and in North America in 1935. Rapid strides have been made since then in the use of laminated wood for structural engineering purposes, especially in North America during the war years, when the need to conserve steel and at the same time provide large buildings for the use of the armed services gave an impetus to engineering in wood. Consequently, structural lamination is to-day far more widely employed in the United States and Canada than it is in Europe, where development has, in general, been on a small scale.

These developments prompted the European Productivity Agency of the O.E.E.C. to send a Technical Assistance Mission to the United States for six weeks, and their report has now been issued. It gives an account in some detail of the manufacturing methods used in the United States, and of factors affecting the design of laminated timber structures, gleaned during a wide tour when 18 organisations were visited and numerous structures seen.

The report states that the American market for laminated timber was of the order of eight million cubic feet in 1953, and that it is likely that this figure will be found to have trebled in 1955. A large share of the market for churches, schools and halls of all types, in which there is an architectural requirement, is now held by laminated timber, and other important outlets are light curved barn rafters for farm buildings, wide-span beams and arches for industrial buildings, and keels and frames for boatbuilding. Some of the larger laminated arches in North America have a span of over 250 ft., while spans of over 100 ft. are commonplace.

Structural laminating implies joining boards together, end to end, with scarf or similar glued joints (Fig. 1), and gluing the resulting long laminates face to face, and occasionally edge to edge, to form a straight or curved member of the requisite dimensions. It is considered that the laminating process has technical and economical advantages which makes it well worth the attention of engineers and woodworking firms in other parts of the world, specially in Europe, where supplies of the raw material are plentiful. The advantages to which the report draws attention are that, before assembly, each piece of wood can be thoroughly seasoned; small faults, such as knots, which naturally occur in timber, can be better distributed; better quality material can be placed at points of high stress; curved members (an important point this) can be readily made by bending boards to the required radius before gluing; and large members can be fabricated from small sizes of timber. In short, better use can be made of timber of a lower quality when it is fabricated into laminated members than when the same timber is used in solid sections.

About one-tenth of the total area of the United States consists of pine forest, and this species of wood is, therefore, abundant and cheap. It is not always obtainable, however, in a form suitable for making solid members of good quality in the large sizes and special shapes which are often required for structural work. Lamination, therefore, by making possible the production of such members from stock material, extends the field of utilisation of the common sizes of timber. The process does not require very specialised or expensive machinery, and this fact, together with the comparatively low cost of the raw material, makes laminating economically advantageous in North America. Although American costs and prices cannot be applied directly to European countries, the mission has made an attempt in the report to estimate production costs in the United Kingdom.

The report goes on to state that in view of the success and progress of the method in America, it considers that similar opportunities for large-scale development exist in European countries, including Great Britain. In fact, in the latter there is already substantial production of laminated sterns, keels and frames and other parts for boatbuilding and naval craft, using hardwoods such as oak and West African mahogany. The material has also been used structurally for the entrance arches—the largest in Europe—to the Festival of Britain buildings in London, for an experimental timber glasshouse at Bayfordbury in Hertfordshire and a village hall at Ickford near Oxford. A laminated-timber footbridge has also just been constructed at Sidmouth in South Devon, and there is little doubt that the O.E.E.C. report will give further stimulus to this technique.

In conclusion, this report, well illustrated with numerous photographs, line drawings and diagrams, with detailed appendices showing tables of working stresses for design in laminated timber, considers that:—

Sufficient technical information and experience is already available to enable most practical problems to be overcome in both the design and fabrication of laminated-timber structures.

In certain parts of Europe the material already competes in price with other materials.

The structures built of laminated timber possess an aesthetic appeal making it particularly suitable for buildings such as churches and halls.

It would be advantageous if timber-laminating industries were commenced in various parts of Europe as extensions to established woodworking factories.

The use of mixed woods, such as strong hardwoods on a weaker core, promises considerable economy and high strength-to-weight ratios, and it is pointed out that research is already being carried out on this subject.

minated-timber stern section of a United States Navy minesweeper being planed down after assembly in the bonding jig.

★ ★ ★

IF ONLY . . .

Engineers' Dreams. By WILLEY LEY. *Phoenix House, Limited, 38 William IV-street, London, W.C.2.* (15*s.*)

Engineers have their moments of creative imagination, like other men; and because their predominant characteristic is practical ability leavened with sound judgment, most of their ideas become facts in the course of time. But sometimes it is the case that engineering concepts that appear quite feasible technically are never realised on account of political or financial objections, or because the advances of science in other directions suggest more attractive means of achieving the same eventual objective. These are the engineers' dreams from which Mr. Ley has selected for description nine examples that are particularly noteworthy, either from the widespread public interest and controversy to which they have given rise, or for inherent possibilities in the service of mankind that are in fact still being explored and exploited.

The dreams fall into two main groups, concerned respectively with overcoming allegedly unfortunate consequences of the present distribution of land and water throughout the globe, and with exploiting inexhaustible resources of energy as alternatives to mineral fuels. The former is the larger group, both numerically and as regards the grandiose scale of some of the schemes suggested. It is almost as though any engineer—at all events any civil engineer—has an instinctive urge to connect two pieces of land that happen to be separated by water, or two bodies of water with land between them. Among projects of this sort, Mr. Ley deals in turn with the Channel Tunnel; the Atlantropa scheme for damming the Mediterranean at Gibraltar and the Dardanelles, thereby lowering the sea level so as eventually to join Tunisia to Sicily and Italy; and the relatively recent, though not widely known proposals for controlling the Jordan Valley and the Dead Sea, and for flooding Central Africa with immense fresh-water lakes to make the Sahara Desert blossom like the rose. Perhaps the most completely developed concept in this group, yet the least likely ever to materialise since aeronautics has already outgrown the need for it, is the Seadrome designed to provide floating stages for transatlantic aircraft.

The other group of ideas in Mr. Ley's selection includes a review of the varied proposals that have been put forward for harnessing the energy available in the sea in the form of tides, waves and difference between the temperatures of the water at depth and near the surface. The remaining projects, for utilising volcanic hot water, the sun's radiant heat, and wind power, have been the subjects of some interesting dreams in times long past as well as of quite active, if not large scale, developments at the present time. The advent of nuclear power for industrial use has no doubt doomed the more ambitious of such concepts, as Mr. Ley points out in his concluding chapter where brief references are also made to a number of less spectacular engineering dreams as well as to some that may well be achieved in the foreseeable future.

It is no disparagement to describe Mr. Ley's book as technical reporting. Obviously he has based his work on the published accounts of earlier writers, but he has done so with a nice discrimination between the fantastic and the feasible, and with critical judgment of the alternative schemes of different inventors. Above all he has produced an extremely entertaining book, no doubt intended primarily to attract a wide range of general readers, but which engineers who can forgive one or two mistakes will also find instructive as well as enjoyable.

SAFETY IN GAS-HEATED DRYING OVENS

DESIGN OF EXPLOSION RELIEFS

Many thousands of industrial drying ovens are in use in this country, the majority being gas-heated. Statistics collected by the Factory Department of the Ministry of Labour and National Service show that about 40 per cent. of the explosions occurring in gas-heated plant were in drying ovens, and that about 80 per cent. of explosions causing fatalities were in ovens of this type. The same statistics showed that the box-type oven was involved in more explosions than any other type. An investigation into the problem of preventing damage and casualties due to explosions in box-ovens was undertaken by the Gas Council at their Midland Research Station, Solihull, near Birmingham, and a report dealing with the design of top reliefs for this type of oven was presented to the Institution of Gas Engineers in the autumn of 1955. The report has now been published by the Gas Council.* Work continues on the problem of back and side reliefs; meanwhile sufficient data exist to enable a safe oven to be designed, and a range of box-ovens incorporating the recommended safety features has been put into production by F. J. Ballard and Company, Limited, Tividale, Tipton, Staffordshire.

DESIGN PROBLEMS

Prevention of damage caused by explosions could be achieved either by preventing the explosions themselves, or by arranging that explosions could occur without causing damage. Safety devices that would prevent the formation of dangerous concentrations of vapours would be complicated and expensive compared with the cost of a box-oven. Attention was therefore directed to the problem of relieving the pressure caused by an explosion in such a way that damage was prevented.

Prior to the Gas Council's investigation, explosion reliefs were sometimes fitted to box-ovens, but no reliable data existed, and the reliefs were often ineffective. They were frequently too heavy, and the importance of this point was not realised. During the experiments at Solihull a relief weighing 60 lb. (similar to many found in use), was projected over 50 ft. vertically upwards; the vent area was 9 sq. ft. and the pressure developed 2·6 lb. per square inch. The damage which could be caused in a factory by such a missile can readily be imagined. Some explosion reliefs, besides being too heavy, had the additional disadvantage of not providing a seal, and some were prone to jam in the vent: in the latter case, of course, the oven had no effective explosion relief at all.

CONSTRUCTION OF A SAFE RELIEF

The experiments undertaken by the Gas Council resulted in the development of a form of explosion relief for the tops of box-ovens which will withstand industrial conditions, and if blown out by an explosion is quite harmless to personnel. Procedures were evolved for determining the area and weight of the relief, and for deciding on the necessary clearance round the oven to ensure that the flame vented by the relief can escape safely. All these data are set out fully in the report, and with them it is a simple matter to make the necessary calculations for either a new or an existing oven, which can be converted with little expense.

The form of relief recommended is shown in Fig. 1. It is supported on a base of expanded metal, this being chosen as it will carry the weight of a person who might step on it accidentally. The expanded metal, of 3 in. mesh with strands $\frac{3}{16}$ in. wide by $\frac{1}{8}$ in. thick, causes a loss of 10 per cent. of the venting area, but this loss can be accepted in view of the safety of the device from above. It is fixed in a vent of a size determined by the formulae given in the report, being bolted to an angle support in the casing of the oven. On it is laid a sheet of aluminium foil 0·002 in. to 0·003 in. thick. This foil is cut slightly larger than the vent, and is pushed well into the corners, but is not fastened in any way. On top of the foil is a layer of mineral wool in the form of slabs, as a carpet, or in broken form; this provides the necessary thermal insulation. In the event of an explosion the foil and mineral wool are projected into the air, giving an immediate vent of the size necessary to prevent damage to the oven. The component parts of the relief then fall harmlessly to the ground, the mineral wool usually in pieces. Even if a piece of the relief should touch anyone on the way down, it is so light, and has such small velocity that it cannot cause injury. A safe distance from the stove for personnel is determined from data given in the report, and the result is that the explosion flame is dissipated harmlessly.

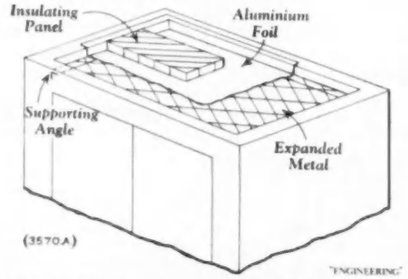


Fig. 1 The type of explosion relief shown here makes a good seal on the top of the oven, and is perfectly harmless to personnel if blown out.

NEW OVEN WITH SAFETY RELIEF

A Ballard oven incorporating the recommended relief is shown in Fig. 2. It is one of a range now in production in various sizes and in three types, double-cased, treble-cased and forced air-circulation. In re-designing the oven to accommodate the new relief the opportunity has been taken to re-style it and to incorporate a number of improvements.

In the double-cased oven the gas burners are arranged at the bottom of the inner casing, and the heat and products of combustion pass up through the casing to a fume ventilator which is piped to atmosphere outside the building. A layer of mineral wool 2 in. thick is placed between the inner and outer casings, giving a high degree of thermal insulation. In the treble-cased oven the outer and inner casings are similarly separated by a layer of mineral wool, and there is a third casing inside the oven which is on the muffle principle. Products of combustion pass between the innermost casing and insulated double outer casing, and thus do not come into contact with the articles being dried. Separate vents are provided for the drying oven proper and the combustion space. The secondary air for the treble-cased oven is ducted in from underneath. Consequently, the oven base is cooled, and the radiated heat is kept as low as possible.

The forced air-circulation oven incorporates an electric fan and a secondary circulating system which gives a more even temperature throughout the working space, and promotes more rapid drying.

ADDITIONAL SAFETY FEATURES

In addition to the Gas Council's recommended explosion reliefs, which are incorporated in the oven tops, the ovens are equipped with flame-failure control, down-draught diverters to isolate the oven from external air disturbances, and reinforced safety doors.

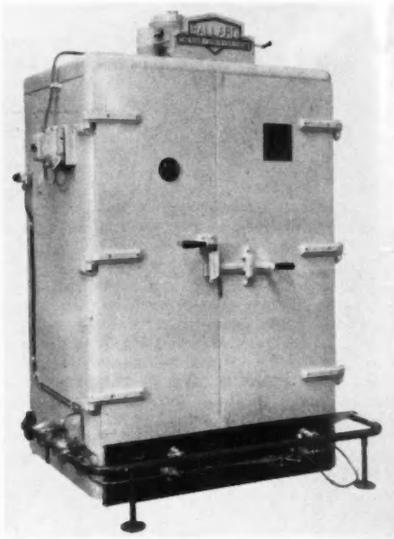


Fig. 2 The Ballard oven designed to accommodate the recommended relief has also been re-styled and incorporates new features.

A Spersom thermo-magnetic valve with safety pilot and thermocouple is fitted to each oven to give protection against gas and flame failure. On the double-cased oven the fume ventilator and down-draught diverter communicate directly with the oven interior. On the treble-cased type two ventilators, both of the anti-down-draught type are fitted, one for the oven interior and one for the combustion space. The doors have specially-designed locking gear. Experience has shown that an explosion is most likely to occur when the door is being opened. If this should happen when the door is freed from its lock, then the safety relief would obviously be inoperative, and the pressure would be released through the door, with great risk of injury to the person opening it. The doors of the Ballard oven are therefore designed so that opening has to be done in two stages. The operator must first move the locking handle to break the joint and let the air in. If an explosion occurs at that moment, the relief releases the pressure, and no harm can come to the operator. A separate and distinct movement of the handle must now be made to release the door finally and allow full access to the interior of the oven. By the time this access is possible, all danger of an explosion is past.

GAS ECONOMISER

The ovens are fitted with dial thermometers in the doors, with dual scales in deg. C. and F. The temperature ranges are 200 to 600 deg. F. and 93 to 315 deg. C. Provision is made for the fitting of a thermostat in either the left-hand or the right-hand side, and a lighting torch can be supplied if required. Gas equipment includes a governor, and a self-lubricating gas cock. The gas feed can be right-hand or left-hand as required, and is interchangeable between these two positions. On the larger ovens the burners are connected to a gas-rail extending across the front; the rail is sufficiently strong to provide protection for the gas gear. On the smaller ovens the gas gear is mounted behind a front panel which extends to the floor.

An extra feature, which can be supplied when required, is a Ballard gas economiser. This is operated by a cam on the door, and cuts the gas supply to the burners when the door is open. It ensures that there is no waste of gas should the door of the oven be left open inadvertently.

* "An Investigation of Explosion Reliefs for Industrial Drying Ovens." 1—Top Reliefs in Box-Ovens, by P. A. Cubbage, B.Sc., and W. A. Simmonds, Ph.D., F. Inst. P. The Gas Council, 1 Grosvenor-place, London, S.W.1.

stitute of Metals Spring Meeting (*continued from page* 269)

ORMING AND SHAPING OF METALS

the third day of the Spring Meeting of the itute of Metals, namely, Thursday, April 12, simultaneous programmes had been arranged the morning and afternoon sessions. Programme "A" was concerned with the presentation and discussion of a symposium of eight papers dealing with "The Final Forming and Shaping of Wrought Non-Ferrous Metals." The papers in programme "B" were on the themes of "Powder Metallurgy," "Embrittlement and Fracture," and "Rolling Textures and Recrystallisation."

The chair at the symposium was occupied by the President, Major C. J. P. Ball, at the morning session, and by Professor H. Ford at the afternoon session.

The title of the first paper in the symposium was "The Machining Properties of Non-Ferrous Metals" and was by Dr. D. F. Galloway, director, Production Engineering Research Association, Melton Mowbray, Leicestershire. He stated that the increasing application in industry of new non-ferrous metal alloys, such as the Nimonic group and titanium alloys, had given rise to new problems of machinability. In some instances the problem had been one not of improving tool life or production rates, but of establishing cutting conditions which would permit the material to be machined at all.

In our present state of knowledge, there appeared to be no substitute for carefully controlled machining tests carried out under conditions closely related to production practice, although one day there might be enough reliable machining data available to permit the validity and range of application of the various machinability tests to be clearly established. The accomplishment of this task would provide a tool as valuable to the production engineer as the hardness test was to the metallurgist.

DRAWING AND SPINNING

The second paper was entitled "The Deep Drawing and Spinning of Sheet Metal, with Particular Reference to Non-Ferrous Materials" and was by Mr. J. A. Grainger, of the chief production engineer's office, Rolls-Royce Limited, Derby. In this contribution, particular attention was devoted to techniques, such as Marforming, Hydroforming, and Flowturning, which provided an inexpensive means of producing small quantities of parts.

The author stated that the displacement of a rubber pad, under extremely high pressures, so as to cause it to conform to the contour of a die block placed between it and the press table, provided a cheap way of producing shallow forms in flat sheet metal. This method was known originally as the Marform process. The rubber pad, in effect, was a universal die which shaped itself to the form of the punch as the drawing operation proceeded and as the pressure was applied. While the Marform process was being developed, work had also been proceeding on similar lines but on a rather more advanced conception, and an entirely new type of machine for deep drawing and forming had been introduced in 1951. The process was termed "Hydroforming," presumably from the fact that the solid rubber pad or block was replaced by hydraulic pressure backing up a rubber diaphragm. This diaphragm was sealed to withstand the high pressures created by the hydraulic fluid—pressures which could rise as high as 15,000 lb. per sq. in.

During the last two or three years a new method of producing close-tolerance articles had achieved prominence. It was a development of spinning and promised to be one of the most evolutionary means of forming deeply-contoured circular articles from thick sheet or thin plate. According to the country practising the art, was known variously as "Flowforming," Stretch Planishing," or "Flowturning." All are essentially the same but at various stages of perfection. In this process, thick-gauge material was made to flow plastically, by pressure rolling, in the same direction as the roller was traversing; and an article was produced, the thickness of which was very much less than that of the blank from which it was made.

The third paper of the symposium was on "Rubber Pressing" and was by Mr. J. Fielding, chief metallurgist of A. V. Roe and Company, Limited, Manchester. The author stated that at first the process had been limited to aluminium alloys, and all pressing was carried out at room temperature. Later it had been modified to include the "hot pressing" of magnesium alloys and, more recently, of titanium. Rubber pressing was a very satisfactory, economical, and well proved process for forming many aircraft parts in aluminium alloys. With magnesium alloys, by hot forming at 300 deg. C., greater deformations were possible than with aluminium alloys, and very accurate components, exactly to die shape could be produced. For titanium, excellent results were obtained by hot pressing at 300 deg. C., particularly on sheets 0·036 in. thick and below.

The fourth paper, entitled "Research into some Metal-Forming and Shaping Operations," was by Mr. W. Johnson, lecturer in mechanical engineering in the University of Sheffield. It contained an account of the results of both experimental and theoretical investigations carried out into the drawing and re-drawing of cylindrical shells with hemispherical and flat-headed punches, with particular reference to the effects of lubrication, drawing speed, and flange wrinkling; ironing; tube-sinking; the detection and measurement of residual stresses in cold-drawn tubes; impact extrusion under a drop hammer; and coining.

The author stated that in cylindrical deep drawing, the primary problem was that of establishing a reliable method for comparing the drawing properties of different materials. After much study it had been concluded that the Erichsen test was inadequate for such purposes, and consequently there was increasing support for the proposal to adopt as a criterion of drawability, the limiting ratio of blank diameter/punch diameter for successful drawing with a 2 in. punch.

COLD ROLL FORMING

The fifth paper of the symposium dealt with the "Cold Roll-Forming and Manipulation of Light-Gauge Sections," and was by Mr. E. Griffin, chief engineer, Metal Sections, Limited, Oldbury, Birmingham. The author stated that, fundamentally, cold roll-forming could be described as a process in which a flat strip of metal was progressively formed into a desired shape by passing through a series of rolls.

Finishing processes for ferrous materials included pre-treatments in phosphating solutions, followed by a subsequent dipping process, or the spraying of various types of protective films. Brass products were usually chromium plated and aluminium alloys were generally finished by anodic treatment.

"Stretch-Forming of Non-Ferrous Metals" was the title of the sixth paper. It was by Mr. R. D. Edwards, production development engineer, Vickers-Armstrongs (Aircraft), Limited, Weybridge, who stated that the term "stretch-forming" was applied to the process of forming wrought metal by the application of tensile loads to the material in such a manner as to cause permanent strain in the varying degrees necessary to produce the required shape, by stretching the material over a tool or stretch block. The stretch-forming process found its greatest and most varied application in the aircraft industry, but it had been employed also for a number of years in coach-body building.

Before commencing stretch-forming, each sheet or section should be examined for nicks or deep scratches on its edges. These acted as stress-raisers when the load was applied and might cause premature failure if not removed by careful draw filing.

Where unit loads between the block and the component were high, high-pressure grease was smeared lightly on the tool by hand, using a rubber glove. Where low pressures only were involved, a light lubricating oil could be applied by brush or spray.

The actual speed of the stretching operation seemed to have little, if any, effect on the result obtained. What was important, however, especially when stretching components prone to buckling, was that the operation should proceed smoothly from start to finish at a uniform rate.

The seventh paper was entitled "Bending and Allied Forming Operations," and was by Mr. T. G. Perry, senior planning engineer, the A.P.V. Company, Limited, Crawley, Sussex, who discussed the metallurgical factors involved in plain bending, tube bending, flanging and rolling. The author concluded that improvements in the range of shapes that could be produced in this class of work would result from a better understanding of the factors that caused difficulty in any particular operation and from the design of tools and material to overcome this. Quality control, as practised in the stage-by-stage inspection, could bring to light many of the difficulties which the craftsman regarded as inherent in the metal or in the design, and the knowledge gained from these difficulties could be applied to simplification of the design and to the selection of special-purpose tools to overcome particular problems.

The eighth and last paper of the symposium dealt with "The Hot Forming of Magnesium Alloys," and was by Mr. R. G. Wilkinson, development manager, Magnesium Elektron Limited, Clifton Junction, Manchester. He stated that magnesium-base alloys, having a closely-packed hexagonal crystal lattice, were capable of limited cold deformation only. Hence, unless the work were very simple, the alloys were usually formed at elevated temperatures, generally between 230 deg. and 350 deg. C.

The forming processes used included straight bending, stretch-forming, rubber pressing, die pressing and deep drawing, hammer forming and spinning. Hydraulic presses were used for rubber pressing, the rubber box being mounted on the upper platen, and the dimensions fixed to give 800 to 1,200 lb. per sq. in. on the pressing area. The rubber pad was usually made up to a thickness of about 6 in. by bonding-up in layers. Special compound natural and synthetic rubbers of about 65–70 Shore hardness, which did not deteriorate too rapidly at operating temperatures, were employed.

DISCUSSION

Mr. W. C. F. Hessenberg, M.A., F.I.M., who acted as *rapporteur*, said that it seemed a pity that space could not be found in the symposium for a short paper on erosive methods of machining such as the spark and ultrasonic processes. Both these were new and still limited in their application, but they had certain potentialities which might have application to the problem of machining some of the tough materials to which Dr. D. F. Galloway had referred. Perhaps this deficiency might be partly made good in the discussion.

It was perhaps a little early to assess the extent to which the flowforming process described by Mr. J. A. Grainger would establish itself at the expense of pressing and spinning. One of the attractions was that the tools were cheap to make, and the process should lend itself to the economical production of limited quantities of various types of thin-walled container.

In connection with Mr. J. Fielding's paper, many people would like to know the meaning of the delightful sounding term "spelching." Mr. W. Johnson, in his paper had given a digest of the metal-forming researches which had been carried out at Sheffield University over a number of years. Much of this work had

arisen out of problems thrown up in the course of an attempt to evolve a drawability test.

By its nature the roll forming process was nearer to mass production than most of the others mentioned, and it was appropriate that Mr. E. Griffin should have raised the question of standardisation as opposed to versatility.

It was clear from Mr. R. D. Edwards's paper on stretch-forming that whatever the extent to which manipulative skill might be replaced, the heart of the matter still remained the design of the tools.

Mr. T. G. Perry's paper on "Bending and Allied Forming Operations" was interesting for the use he made of the stress-strain curves as a guide to the behaviour of metals in bending and forming. Moreover, it would have been noticed how much of this symposium had been concerned with geometry rather than metallurgy, and it might well be that geometry had more to contribute than metallurgy towards future advances in this branch of technology.

The advantages of working magnesium at about 300 deg. C. were brought out in Mr. Fielding's paper, and Mr. R. G. Wilkinson in his paper introduced some of the practical problems. To the uninitiated, some of the heating methods described in the paper might seem a trifle crude. Bearing in mind the need for quick working with cold-worked magnesium, one wondered whether there was not some scope for electrical methods of heating.

ALUMINIUM SLABS

Mr. F. H. Parker, who opened the discussion, said that he believed that the aluminium industry, within twelve months, would be offering to the aircraft and other industries large wrought high-strength aluminium slabs. Much money had been invested in plant to produce these slabs, including rolling, heat-treatment and subsequent stretch-forming equipment. He would like to suggest to the aluminium industry that they go just a little further and, for an expenditure of what should be not more than another 20 per cent., consider putting in the allied machining processes so that they could offer not just a soulless wrought slab but the complete fabrication and machining to customers' requirements—a much more valuable and profitable proposition.

Mr. J. A. Ambler supported the plea that the measurement of the percentage reduction obtained under standard conditions was the most satisfactory method of comparing drawability. He added that this test also indicated to what extent the material possessed directional properties, which were very undesirable in deep-drawing operations.

Mr. J. Ferdinand Kayser said that in his first paragraph Mr. Griffin had stated that basic strip material, produced on continuous mills, excelled all other ferrous and non-ferrous products in uniformity of thickness, consistency of properties, and surface conditions. He could not agree with that. Up till a short time ago, part of the strip used by his firm, Gillette Industries, Limited, was made on small mills that were over 50 years old, and it was more consistent than material from modern continuous mills. Apparently the specification that covered strip and sheet metal had been drawn up to accommodate the most antiquated mill in existence. It was possible to buy No. 28 gauge strip aluminium in accordance with B.S. specification 1470 and obtain material which varied in thickness to the extent of 20 per cent. Material like this was not suitable for mass production purposes.

ERICHSEN TEST

Mr. J. F. Lancaster said a few words in defence of Erichsen, who did not get much acclamation these days. There was one thing about his test: it was swift and this was important when time was costly. At the A. P. V. Company, a modification of the Erichsen test had been used for a number of years. It had been developed by W. K. B. Marshall, for the control and investigation of materials for heat exchanger-plate pressings. The modification consisted in using a 1 in. wide strip, in place of a 3½ in. square, with a correspondingly smaller cup size, and operating the punch and die in the compression grips of a Hounsfield tensometer. In this way the required blank size was small—a minimum of 1 in. by 3 in. —and an autographic record was kept of the cupping operation, giving both cup depth and maximum load at failure. Most of the experience with this test had concerned its application to stainless steel used for pressing heat-exchanger plates, but recently work had been carried out on a limited number of non-ferrous alloys.

Mr. E. E. Spillett said that Mr. Fielding had mentioned that by hot forming at 300 deg. C. greater deformations were possible with magnesium alloys than with aluminium alloys. He would like to know whether this comparison was made with aluminium at room temperature or at 300 deg. C. Aluminium alloys, like most materials, could be worked more easily and to a greater extent if warm, but presumably the complication of providing heated blanks, etc., had not encouraged any wide-scale adoption of this practice. It was well known that metal itself became warm on pressing, and it should be possible to take advantage of this, in multi-stage pressing, if subsequent operations were carried out quickly.

Mr. F. King said that in the aluminium industry few complaints about machineability were concerned with tool life. In those cases which did arise, it had been found that constituent size and its distribution influenced tool life. Brittle constituents such as silicon could cause heavy tool wear. On the other hand, low melting point constituents caused chip formation, giving long tool life.

Mr. R. W. Hancock said that there were hundreds of applications where localised annealing would be the answer for which the commercial press men were looking. They had been asking for it ever since he had been in the industry, so far to a deaf ear. It must be coupled with commercial practicability and it must cheapen the eventual product, or there was no point in it.

He agreed with Mr. J. A. Grainger that when working non-ferrous metals in the lower strength range—for example, aluminium and the low-strength alloys—it was of the utmost importance to use tools which had been finished to a very high standard of surface polish, and in which the blending of the die radius had been carefully and accurately carried out, and that polishing should be done in a radial direction. This was a very important point which was not always appreciated. On the question of stretch flanging he would like to underline Mr. J. Fielding's warning that "scratches, scriber marks and other stress concentrations on the material edge must be avoided." It was surprising how often neglect of this obvious precaution led to splitting and edge cracking.

Mr. W. Johnson said that their work had been done on thicknesses greater than 0·02 in. An account had been given of the research by Professor Swift to the British Association. It had been published in ENGINEERING.* The correspondence started in ENGINEERING had brought to their attention the fact that some of the general conclusions they had reached concerning working with material greater than 0·02 in. did not agree with the experiences of others and was contraverted at lesser thicknesses.

Mr. J. G. Wistreich said that reference had been made to a test for the production of shells—the reverse bend test. On the face of it, one wondered what was the connection between bending a metal to and fro and forming it into a shell. The answer was that the test seemed to answer the purpose.

There were many tests of this kind, and they formed a very useful aid and performed a useful function. The only difficulty was that when one wanted to compare experiences between one company and another, it was difficult to reach a common language. It was clear that metallurgists throughout the country had either devised their own tests or had selected a test and made it work in their own field.

Mr. J. Fielding said that Mr. Hessenberg had referred to the use of the word "spelching." It signified the pick-up of the specially strengthened laminated hardwood.

* Vol. 178, page 431 (1954).

To be continued

BRITISH INDUSTRIES FAIR

ELECTRICAL EXHIBITS AT OLYMPIA

Continued from page 286

1,000 MVA SWITCHGEAR

The principal exhibit on the stand of South Wales Switchgear, Limited, Blackwood, Monmouthshire, is the oil circuit-breaker illustrated in Fig. 6. This has been designed for outdoor service on 33 kV circuits and has a rupturing capacity up to 1,000 MVA at 800 or 1,200 amperes. As will be seen, the unit is self-contained and has either hand or motor-wound spring or solenoid operated closing mechanisms, which are mounted in a weatherproof cubicle.

The top plate consists of a silicon-aluminium alloy casting and incorporates pebble-filled vents, which allow the gases to escape without the emission of oil. All the surfaces adjoining the bushings are machined to ensure joint tightness. The tank is of fabricated steel plate and is lined with insulating material of high dielectric strength, sheets of similar material being interposed to act as interphase barriers. The tank is bolted to the top plate and sealed with a rubber insert. The cubicle housing the mechanism, auxiliary and control switches and heating elements is waterproof.

CONTACT DESIGN

The combined main and arcing contacts of the breaker are of the self-aligning "rose" high-pressure line-contact type. This design ensures that minimum contact burning occurs during short-circuit operation. The contacts are mounted inside an arc control device of synthetic-

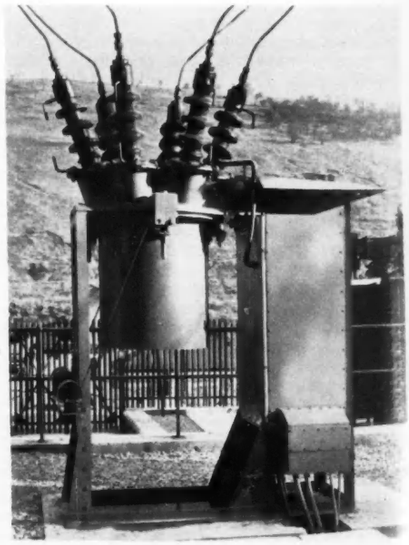


Fig. 6 1,000 MVA, 33 kV oil circuit-breaker South Wales Switchgear Ltd.

in bonded fabric tube with resin-impregnated pressed wood throat plates. The arc control ce itself operates on a side-cross jet principle positive arc extinction is effected on short- uit by the cross-jet compensation chamber. s arrangement gives consistent operation in the arc control device over the range of rt-circuit capacities of the equipment.

The moving contacts are of the " candlestick " e, the lifting rods being of high tensile strength sulating material and running within guide rriers to ensure permanant alignment. The ontact assembly at the end of the opening stroke is cushioned by oil-filled dash pots.

The terminal bushings, which are of the synthetic resin-bonded paper condenser type, are wrapped directly on the conductors, the outer condenser foil layer being brought out to earth through the bushing flange. The exposed portion of the bushing is protected by an oil-filled porcelain shroud, which is provided with " anti-fog " weather sheds and has an insulation level of 44 kV. Ring type current transformers can be fitted on either the incoming or outgoing, or on both sides, of the circuit breaker.

Fig. 7 New " Megger " insulation tester for three-voltage operation: Evershed and Vignoles, Limited.

TWO NEW INSTRUMENTS

Evershed and Vignoles, Limited, Acton Lane Works, Chiswick, London, W.4, are exhibiting two new types of their well known " Megger " instruments. The first of these, which is illustrated in Fig. 7, has been developed for three-voltage operation with testing pressures of 100, 250 and 500 volts and is capable of measuring insulation resistances up to 10,000 megohms. In principle the construction of this instrument is the same as that of the Series 1 insulation tester on which voltages up to 2,500 volts can be generated, but it incorporates a transformer and the lower voltages can be selected by a switch. Three types—hand driven, hand-and-motor driven or mains operated—are available and each incorporates a constant pressure direct-current generator. The motor-ised testers are particularly useful when carrying out prolonged tests which involve the application of the voltage for half an hour or more, as is sometimes necessary. Every set is fitted with a moving-coil ratiometer movement, which is a true ohmmeter, the accuracy of the readings being unaffected by any variation in the voltage.

Another instrument shown is an addition to the range of the firm's Series 2 instruments. It is of the three-voltage hand-driven type with testing pressures of 250, 500 and 1,000 volts and a range up to 200 megohms. The case of the intrinsically safe circulation and continuity tester in this series is now of steel instead of aluminium in order to conform with a National Coal Board directive on the possible unsuit-ability of using the latter metal at the coal face.

In addition to the other testing sets which are being shown, a section of the stand is being devoted to a display of recording, measuring and indicating instruments of both the switchboard and portable types. This includes a miniature recorder.

FRACTIONAL HORSE-POWER MOTOR

Brook Motors, Limited, Empress Works, Huddersfield, are exhibiting a full range of their products, both at Olympia and Castle Bromwich. Among these is the new fractional horse-power motor illustrated in Fig. 8, which has been designed to fit into confined spaces. A shorter model for fitting to washing machines is also available.

The stator is a heavy-gauge single steel shell with the stampings pressed in and locked in position. Detachable pressed steel feet are secured to the frame by four bolts. The windings are insulated with synthetic resin, interleavings of varnished cloth being inserted between the coils and at all cross-overs. The slots are also insulated and the finished stators are immersed in varnish and then baked to increase their mechanical strength. The rotor is of pressure-cast aluminium passing through iron laminations and the end rings incorporate fan blades. The end-shields can either be of cast iron or pressure die-cast aluminium. The bearings are of the sleeve type and resilient mountings can be supplied to eliminate noise or vibration.

The motors are designed for five voltage ranges between 200 and 250 volts and to run at full-load speeds of 1,420 r.p.m. or 1,720 r.p.m., depending on the frequency. The starting winding is controlled by an internal centrifugal switch and thermal cut-out protection can be provided.

Another motor with fractional horse-power output is of the vertical-mounting sleeve bearing type, which will carry loads up to 28 lb. In addition, a number of larger motors with outputs up to 600 h.p. are being shown.

The same firm is exhibiting a push-button starter for motors up to ½ h.p. This is mainly constructed of die castings, plastic mouldings and metal pressings, so that it can be produced at a minimum cost for labour.

MODELS

A feature of the Olympia stand of the Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, 17, is the number of models that are being shown, this of course being one consequence of the increasing size of electrical plant. Among these models mention may be made of the one illustrated in Fig. 9, which depicts a 17,100 kVA alternator driven by a Boving water turbine at a speed of 600 r.p.m. This machine, which generates three-phase current at 11·5 kV, is one of four which have been manufactured at Trafford Park for the Kiewa hydro-electric scheme of the Victoria State Commission, Australia.

Other models on the same stand, which attract a good deal of interest, are two relating to the Castle Donington power station in the East Midlands Division of the Central Electricity Authority. One of these is a scale model of the station which, when completed, will house six generating units with a total capacity of 600 MW, making it one of the largest in Great Britain.

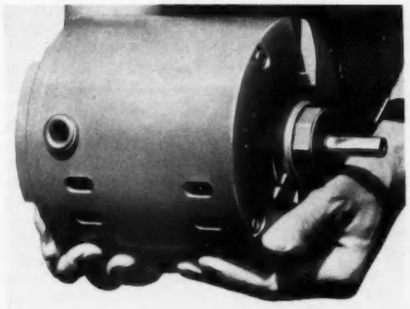


Fig. 8 Fractional horse-power motor for use in confined spaces: Brook Motors, Ltd.

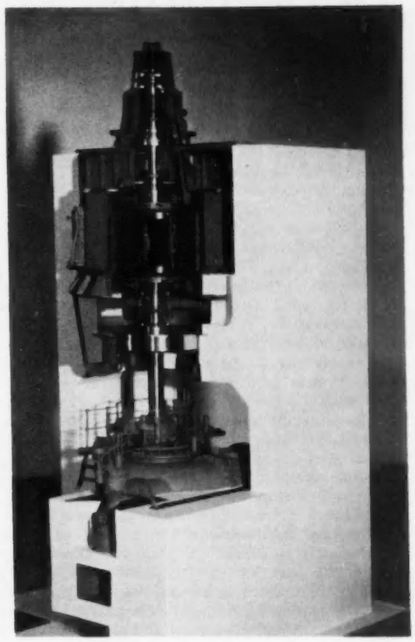


Fig. 9 Model of 17,100 kVA water-turbine driven alternator for the Kiewa hydro-electric scheme, Australia: Metropolitan-Vickers Electrical Co., Ltd.

The whole of the generating plant, including the steam turbo-alternators, condensers and feed-water heating equipment, is being supplied by Metropolitan-Vickers. The model is cut away to show the layout of the main equipment and also indicates the position of the six Metropolitan-Vickers' generator transformers, which are being erected adjacent to the main building.

The second model shows one of the actual turbo-alternators at Castle Donington. This has been made to scale and is sectioned to exhibit the internal construction of the hydrogen-cooling system.

WEATHERPROOF MOTOR

Among the actual equipment on view on this stand is a 25 h.p. weatherproof or splash-proof ventilated squirrel-cage motor for general industrial duty. This is shown running under a continuous spray of water in order to demonstrate its suitability for use in damp or wet situations, such as those for which the more costly totally-enclosed or totally-enclosed fan-cooled machines are usually specified. These motors are being made with 50 cycle ratings from 20 to 100 h.p. at 1,425 r.p.m.; from 20 to 75 h.p. at 960 r.p.m.; and from 20 to 60 h.p. at 725 r.p.m.

Mention may also be made of the thermal reactor equipment which is being exhibited on this stand. It is an actuating mechanism for the combined control and shut-off rods of a thermal reactor and is designed to provide a slow " out " and two faster " in " speeds and to hold the rod in any required position. It can also give a controlled shut-off of the reactor independently of the electricity supply.

The mechanism consists of a synchronous control torque motor which is fed from a variable frequency supply and drives a cable reel through 20 to 1 reduction gearing. The speed of the rods to the shut-off condition is controlled by a permanent-magnet eddy-current brake. The position of the rod is indicated by a geared Magslip transmitter. The entire mechanism is dry-lubricated by molybdenum disulphide. The company is supplying 120 of these mechanisms for the Calder A power station of the Atomic Energy Authority.

To be continued.

TRANSONIC TUNNEL FOR AIRCRAFT INDUSTR

CO-OPERATIVE RESEARCH AT BEDFORD

With the opening on Friday, May 4, of the new transonic wind tunnel at the Aircraft Research Association, Bedford, by H.R.H. the Duke of Edinburgh, the British aircraft industry now has available a valuable development tool for investigating the transonic region on large aircraft models. Although in America the idea of co-operative wind tunnel research has been long established, it has never before been the practice in the United Kingdom. Hitherto, aerodynamic development has been carried out in individual tunnels of limited size owned by firms, or in the Government wind tunnels at the Royal Aircraft Establishment. The volume of long-term research work is now, however, so great as to absorb fully all the facilities of the Royal Aircraft Establishment; and the work that can be carried on in the smaller tunnels within the financial scope of the individual firm is limited.

For this reason, 14 British aircraft firms have co-operated to bring into being this new tunnel, designed for testing models with spans of about 3 ft. and at speeds from Mach 0·6 to Mach 1·3; the tunnel will be operated by the Aircraft Research Association formed for the purpose, and each member firm will contract out its wind tunnel work to the Association, being allocated an amount of tunnel time proportional to its financial contribution to the Association. A plan of the site is shown in Fig. 1. In addition to the transonic tunnel, a supersonic tunnel for speeds from Mach 1·6 to 3·4, with a working section 2 ft. 3 in. wide by 2 ft. 6 in. high, is under construction and is expected to be in operation early next year, and a small intermittent transonic tunnel with a working section 9 in. by 8 in. will also be built to enable model rigs to be tested before embarking on large-scale tests in the big transonic tunnel.

FLEXIBLE-WALL NOZZLE

The main transonic tunnel, which incorporates a new type of flexible-wall nozzle and an interesting "model cart" arrangement for installing the models in the tunnel, has a working section 9 ft. wide by 8 ft. high, capable of accommodating models nearly 6 ft. long with a span of 3 ft.; it operates over a pressure range of 0·8 to 1·2 atmospheres absolute. With a 3 ft. model the Reynolds number at Mach 1 is approximately 4×10^6. An air-mass flow of 1·75 tons per second is provided by a two-stage 20 ft. diameter fan driven by a 20,000 h.p. (continuous rating) slip-ring induction motor; the maximum 2 hour rating of this motor is 25,000 h.p.

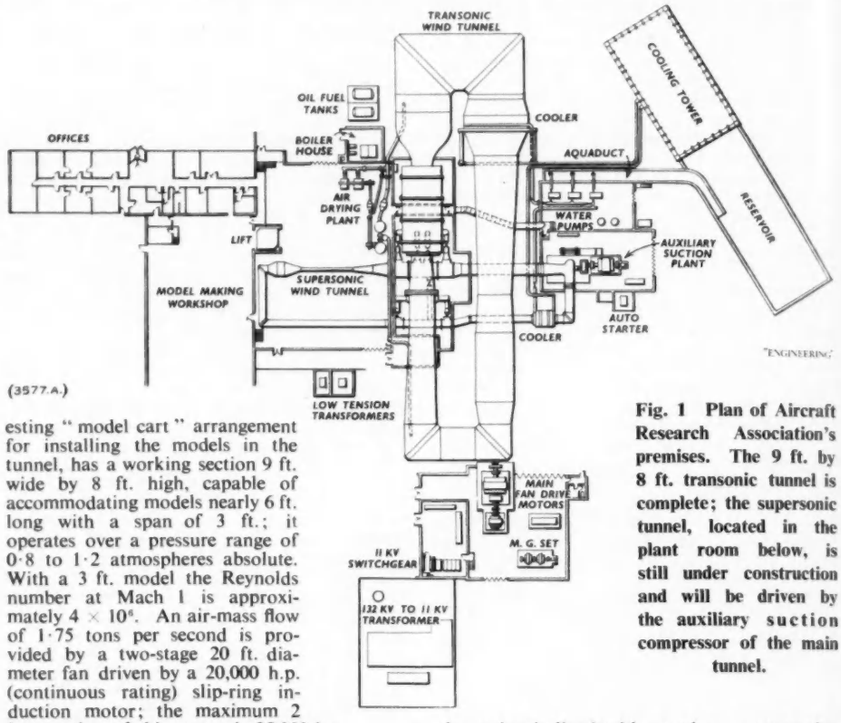
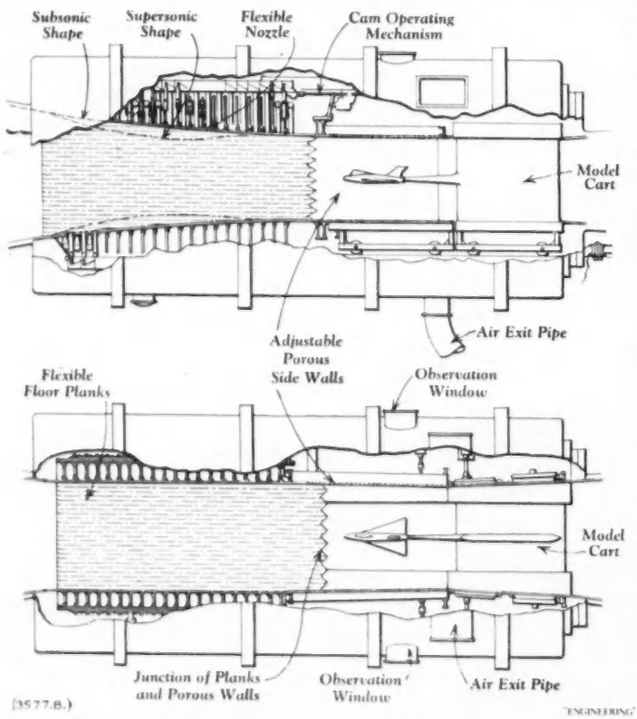


Fig. 1 Plan of Aircraft Research Association's premises. The 9 ft. by 8 ft. transonic tunnel is complete; the supersonic tunnel, located in the plant room below, is still under construction and will be driven by the auxiliary suction compressor of the main tunnel.

The tunnel is of the conventional closed-circuit type with a ventilated working section, and has a removable section to give access to the working section. The circuit includes a bank of cooling radiators just before the third corner and a stainless-steel smoothing screen before the contraction. The air circulating through the tunnel is dried to maintain the moisture content below 0·001 lb. of water per lb. of air—a precaution necessary to avoid the formation of condensation shocks at high speeds.

Most of the tunnel shell is octagonal in shape and is constructed in $\frac{3}{8}$ in. flat steel plates with stiffening ribs and frames. At the working section, where the pressure is reduced to about one-third atmosphere absolute, the tunnel is enclosed in a pressure cylinder built from $\frac{1}{4}$ in. steel plate. The removable section immediately downstream of the working section is rectangular and is mounted on a rail carriage so that it can be detached from the tunnel circuit and shifted laterally, by its own electric drive motor, to permit installing the models. A retractable seal ensures that the tunnel is sufficiently airtight when the section is in place. The part of the tunnel enclosing the fan is of circular section 21 ft. in diameter, and the casing is lined with wood as a precaution against the destructive effects of fan-blade failure. The shaft of the fan is taken through the second corner of the tunnel. The tunnel shell is fixed at four points, in both directions at the fan section and downstream of the fourth corner, the other two fixing points being in the longitudinal direction only. In each long section of the tunnel is an expansion joint.



Figs. 2 and 3 Elevation and plan of the working section, which has a flexible nozzle, and perforated walls in the vicinity of the model.

VENTILATED WORKING SECTION

As noted above, the working section (Figs. 2 and 3) is ventilated to avoid choking at speeds in the region of Mach 1. This is carried out by an auxiliary suction pump comprising a Brown Boveri 11-stage axial flow compressor with a capacity of 300,000 cub. ft. per minute, driven by a 9,900 h.p. (continuous rating) English Electric synchronous motor with a maximum rating of 13,750 h.p. This plant reduces the pressure in the working section to one-third to one-half of the tunnel atmospheric pressure and returns the sucked-out air, recompressed to atmospheric pressure, to the tunnel circuit immediately downstream of the removable section.

Upstream of the ventilated section is the flexible-wall nozzle where air is accelerated to supersonic speed. The parallel side walls of this section are fixed, the top and bottom being adjustable in shape in nine steps for speeds ranging from Mach 1 to Mach 1·6. (At present the tunnel will not be operated above Mach 1·3). In this section all the walls are built of cold-drawn steel strip, those on the top and bottom being 4 in. wide by $\frac{3}{8}$ in. thick and those on the side walls 5 in. by $\frac{1}{2}$ in. thick. They are fixed to cross members by counter-sunk bolts; the bolt holes are filled with Araldite and the spaces between the strips are sealed with rubber strips to give a smooth surface. In this way the desired surface finish has been obtained much more economically than would be the case if the walls had been composed of large single machined plates.

The method by which the roof and floor are flexed is unconventional. As may be seen in Fig. 4 the roof and floor strips are fixed by hinges to cross members at 13½ in. centres. These cross members are pivoted on vertic

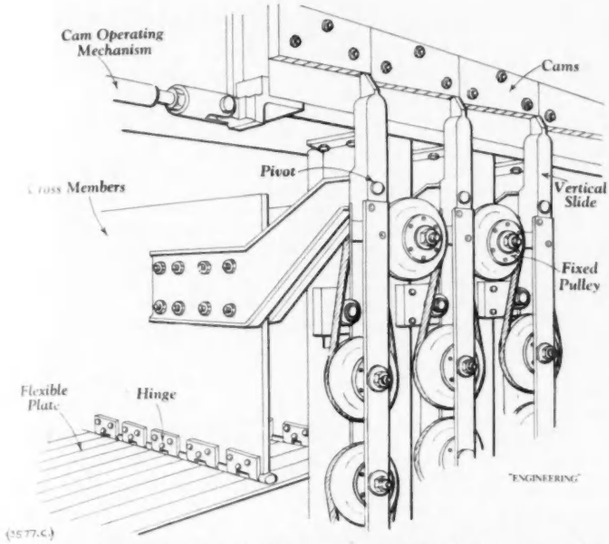


Fig. 4 The flexible top and bottom walls are hinged to cross-members pivoted on vertical slides retained by a series of stepped cams. Each slide can be raised or lowered by a pulley and cable system, and the cams can be shifted longitudinally by screw jack to enable the wall profile to be changed.

slides on each side, the slides being retained in position to give the desired nozzle shape by a series of cams cut in steps. Each slide can be raised or lowered by means of a linked cable and pulley system. The way in which the shape of the roof or floor is altered is as follows: the slides, all operated simultaneously, are pulled off the cams which can then be shifted longitudinally by means of screw jacks, a step at a time; the slide is then pulled back on to the cam by the other pulley system. The winding drum operating the cable and pulley system located outside the tunnel is electrically driven by a slip-ring motor.

The entire flexible-nozzle system is controlled by push buttons on the control desk in the observation room. It is possible to operate at Mach numbers intermediate between these steps by varying the suction through the ventilated walls downstream. Immediately downstream of the flexible nozzle is the ventilated section, 12 ft. long, where the models are located. All four walls here are perforated. The top and bottom walls of this section are fixed but the side walls can be flexed approximately ± 1 deg. about the upstream ends by means of hydraulic motors operating through a gearbox and chain drive to screw thrustors. This provides a means of controlling the boundary-layer thickness on the walls of the working section, the downstream end of this section being pneumatically sealed.

MOBILE "MODEL CARTS"

Referring to Fig. 6, it will be seen that adjacent to the removable section is a rail track and turntable system connecting with five bays where the test models are stored. For installation in the tunnel, the model is mounted, by a sting extending from the rear of the body, on a "model cart" which travels along the rail into the tunnel. In the working section the "cart" is engaged by clamps at the top and bottom. The arrangement of the model cart can be seen from Fig. 5. The sting is pivoted to a vertical strut which can be shifted vertically relative to the cart frame by means of a screw driven by a hydraulic motor mounted below the floor in the working section of the tunnel, the connection between the screw on the model cart and the motor shaft in the tunnel being by means of a universal coupling. The rear end of the sting which extends beyond the pivot is linked through lever system to the cart frame, so that this mechanism will allow the incidence of the model to be changed by shifting the strut either up or down, the vertical position of the model remaining approximately constant. The incidence range is from + 22 deg. to minus − 10 deg.

The model cart is designed to withstand a maximum lift load of 6,000 lb. and side force of 2,000 lb. on the model. Provision is also made for rolling the model. By rolling and then changing the incidence, angles of side slip can be obtained and measurements made on static lateral and directional stability.

The tunnel will also be used for testing half-wing models mounted on "half model carts" which comprise four-component balances measuring lift, drag, pitch and rolling moment, the floor of the balance forming a reflection plate. This technique is rather new to this country and its possibilities have still to be explored.

FAN CONSTRUCTION

As already mentioned, a two-stage fan is fitted, each stage having 20 fibreglass-covered mahogany blades. Before the first stage there are 11 pre-rotation vanes, and 22 before the second stage; downstream of the second stage are 11 straightening vanes (Fig. 7). The pre-rotation vanes are provided with adjustable flaps, the incidence of which can be altered from + 10 deg. to − 20 deg. This enables the power output of the fan to be varied at a given rotational speed and provides an alternative method for controlling the wind speed; it is hoped by means of these flaps to develop an automatic speed control system based on tunnel Mach number.

The main English Electric 20,000 h.p. slip-ring induction motor, which has a maximum speed of 485 r.p.m., is controlled by a liquid resistance and by a 1,500 h.p. direct-current motor coupled directly to the main motor. The direct-current motor is controlled by a Ward Leonard system using a direct-current generator driven by a 1,770 h.p. synchronous motor; the motor generator set has been built by British Thomson-Houston Company, Limited. By this means the speed can be maintained to within $\pm 0{\cdot}1$ per cent. The drive to the fan is taken through a 37 ft. shaft coupled by two semi-flexible couplings which permit some misalignment of motor and fan shaft; upstream of the fan is a thrust bearing.

COOLING AND DRYING

Cooling water from the local waterworks passes through a water softener before entering the reservoir from which it is pumped through the 6,000 gallon tunnel heat exchanger comprising four rows of finned copper tubes, located at the third corner. This keeps the air temperature in the tunnel at no more than 25 deg. C. above the outside temperature. From the bottom of the heat exchanger the water is pumped to the top of a fan-cooled film cooling tower and falls into a 200,000 gallon reservoir. The temperature drops about 10 deg. C. by evaporation as it falls. This cooling tower and the pumphouse, handling 600,000 gallons per hour, also serve the coolers for the auxiliary suction plant and the liquid resistance of the main fan motor, as well as various oil coolers.

The drying plant, located in the plant room below the main tunnel circuit comprises two Birlec alumina plants capable of handling 4 lb. of air per second, and small centrifugal compressors which enable the tunnel pressure to be raised or lowered by one-fifth atmosphere above or below atmospheric pressure. One dryer works on a continuous bypass system, the other being used to dry any additional air pumped into the tunnel. Each has a life of about 6 to 8 hours before reactivation is necessary.

MODELS

The test models are generally made in steel to withstand the high air loads; they are machined in the Association's own machine shop, which is well equipped with hydraulic copy milling machines and other advanced machine tools. There is very little experience in the United Kingdom on the manufacture of such large high-precision models, which require to have an accuracy of contour within $\pm$ 0·001 in. At present, progress is being made with the tangent plane method for forming wings, evolved in the first place at the National Physical Laboratory. Bodies are formed on the Hydrotel and other hydraulic copying machines. The Association hopes to produce about 26 models a year.

Within the model body is mounted the strain-gauge balance unit on which all the forces and moments acting on the model are measured. The unit itself is machined in alloy steel and on it are mounted resistance wire strain gauges and their associated circuits which enable lift, drag, side force, pitching moment, rolling moment and yawing moment to be measured. The balance units have to be calibrated in a rig provided in one of the model bays.

CONTROL ROOM

Adjacent to the working section is the control room, from which the tunnel is operated and the measurements are recorded. A small window is provided from the control room through

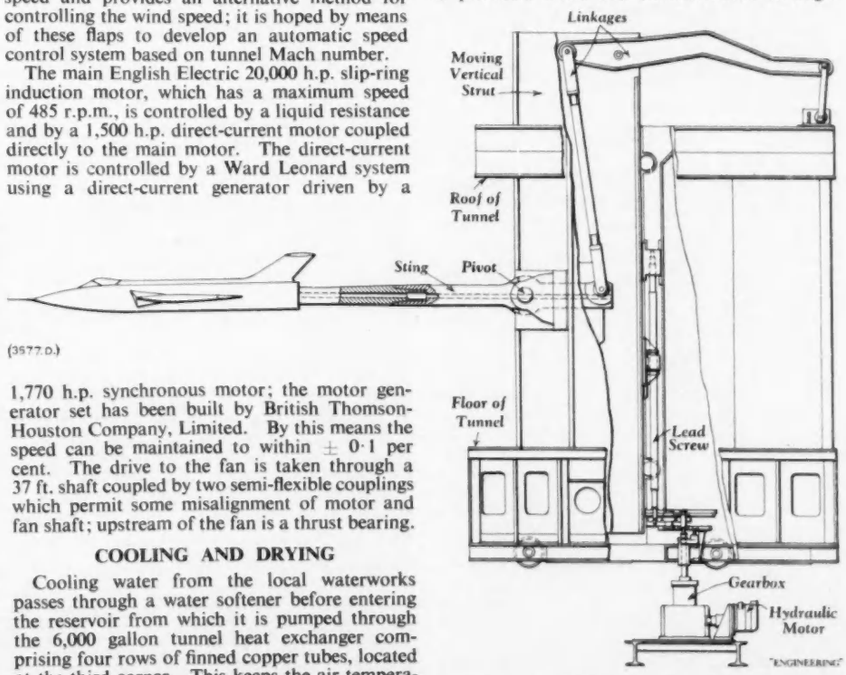


Fig. 5 The model is mounted on a sting pivoted on an adjustable vertical strut on a mobile "model cart," enabling the model incidence to be changed without sensibly altering its vertical position. The model cart is clamped in position in the tunnel and coupled up to the incidence drive motor before the start of a test.

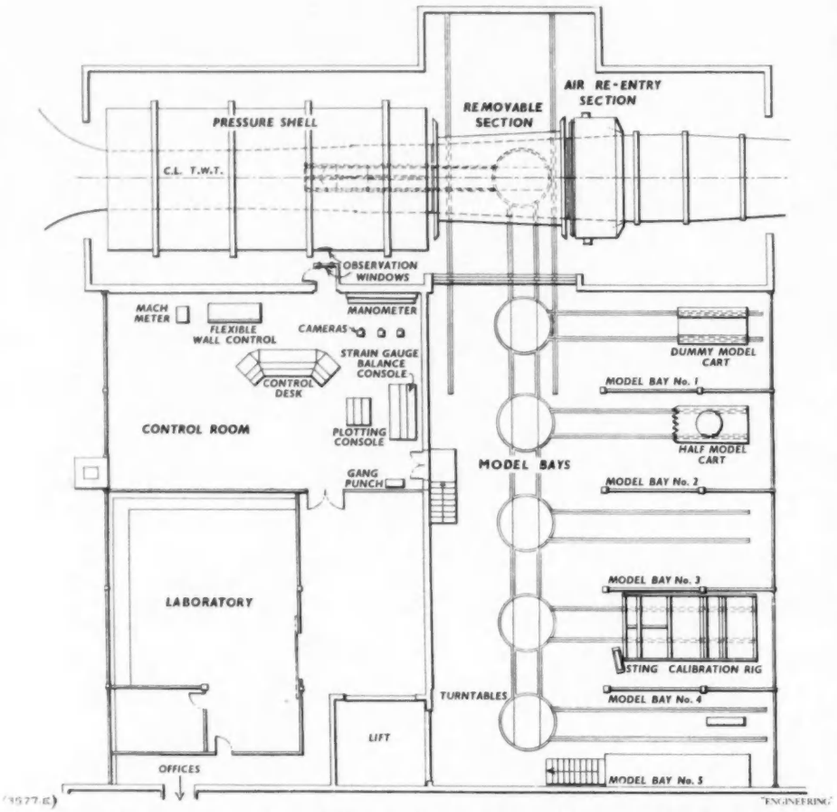


Fig. 6 Model carts are stored and balance units are calibrated in bays adjacent to the tunnel working section. Rail tracks and turntables connect the bays with the removable section.

the pressure shell of the tunnel, but the view afforded is very limited; a television camera and screen have therefore been provided to allow the operator to observe the behaviour of the model, the screen being located near the tunnel control desk. On this desk are the starting and speed controls for the tunnel, controls for the auxiliary suction plant, dryers, evacuating compressors and the flexible-nozzle push-buttons. Another desk is used for measuring the forces on the model, with an automatic plotter and card punch close by. For pressure-plotting, a multiple-tube wall manometer is provided which is flood-lit and photographed by a F24 camera. Because the evaluation of such records is a lengthy process, however, an alternative method has been devised, as described below.

RECORDING AND COMPUTING

The signals from the strain-gauge units are led to the control room to a series of Boulton Paul self-balancing servo units, on which a reading of the force is displayed visually on a dial. For recording purposes, the signal is converted by the servo unit to digital values that are transmitted to storage relays where they are converted to an ordinary binary-scale system. The binary signals are used to punch cards which are fed to a Hollerith HEC 2 M electronic computer, with a fast multiplier and magnetic drum storage, in the plant room below the control room. The binary impulses also operate an automatic plotter so that the operator can examine the results as they come in. This data, however, obtained directly from the loads and moments on the model, requires to be converted to coefficient form for the record. This is carried out in the electronic computer, producing another card punched with the coefficients which can then be fed to a card-reader, operating an electric typewriter, for tabulation. It is intended, also, to supplement the tables by plotting graphs from the corrected cards. Something like 1,000 arithmetical operations, it is stated, are required to correct the results of a single six-component measurement to coefficient form; the Hollerith computer does this operation in about a minute and may possibly be modified to speed up the operation still more. Thus it is expected that it will be possible to examine the result of the test within an hour or so.

As already mentioned, the Aircraft Research Association is developing a speedier method for pressure plotting. The instrument comprises a very compact pressure-capsule transducer with four Baldwin and Hamilton AB 11 type wire resistance strain gauges mounted on a flexible diaphragm $\frac{3}{4}$ in. in diameter. This is enclosed in a capsule box 1 in. in diameter and 0·3 in. thick. It has proved possible to mount 24 such gauges in a typical model nose The Association claim that these gauges give a linear response over a range of 0 to 20 lb. per sq. in. with an overall accuracy better than 1 per cent. The signals from these gauges amplified can be used in conjunction with the punched card system.

The contractors for the main tunnel shell were Moreland Hayne and Company Limited. For the contraction cone cooler, structure working section, shell removable section and air entry section, G. A. Harvey and Company Limited. For the working-section flexible nozzle and the model cart, the Chatwood Safe and Engineering Company Limited. The main contractors for the buildings were Robert M. Douglas (Contractors) Limited. The main electrical contractors were English Electric Limited and the auxiliary suction compressor was supplied by British Brown-Boveri Limited.

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ANODISED ALUMINIUM WIRE FOR ELECTRICAL EQUIPMENT

After several years of research, the metallurgists of Aluminium Limited, Montreal, Canada, have developed a new process for producing on a commercial scale a ductile anodised coating on aluminium wire by the use of alternating current. The coating in effect becomes an electrical insulation. In a statement issued by Aluminium Union, Limited, The Adelphi, John Adam-street, London, W.C.2, the distributors in the United Kingdom for Aluminium Limited, Montreal, it is stated that the process is continuous and involves pulling the wire through tanks containing chemical solutions which quickly give it a thin, hard coating that is sufficiently ductile to withstand the stressing and flexing operations involved in winding electrical coils. The lack of these properties, it is pointed out, has prevented the use of anodised aluminium wire for this purpose in the past. The coating varies in colour from white to dark grey according to the electrolyte used. It is emphasised that aluminium oxide, built up by anodising, is an insulator that maintains its insulating properties at very high temperatures. Hence, electrical motors and other equipment, wound with this light, heat-resisting aluminium wire, could be made smaller and lighter and could run at much higher temperatures than is now the case.

Aluminium Union Limited are co-operating with electrical equipment manufacturers in resolving a few technical problems, connected with the wider use of the wire.

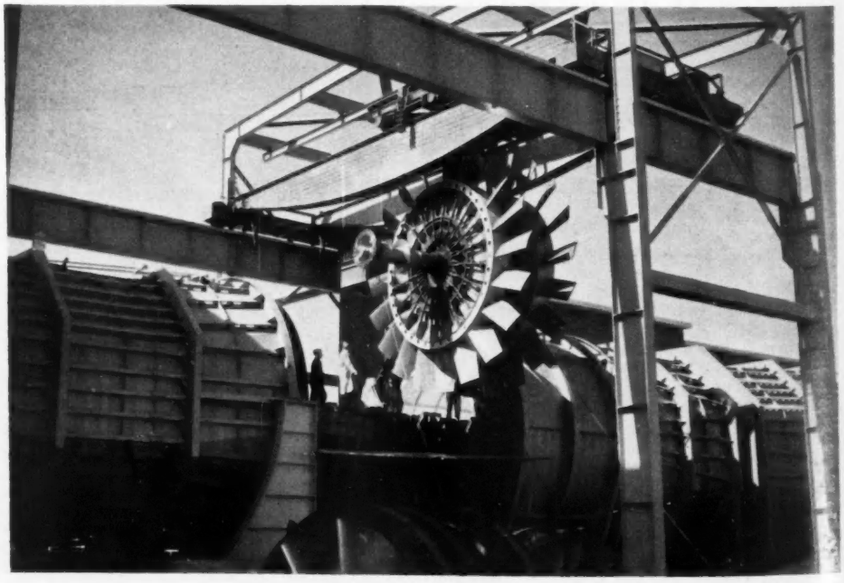

Fig. 7 Erecting the two-stage 20 ft. diameter fan in the tunnel. The fan shaft is coupled to its drive motor by a 37 ft. cardan shaft taken through the end wall of the tunnel.

MODERNISING THE DOXFORD*

RECENT IMPROVEMENTS AND ADDITIONS TO A MARINE ENGINE

As common with many other Diesel engines, the main recent development applied to the Doxford engine has been that of supercharging. Investigations on a three-cylinder two-stroke opposed-piston engine of 600 mm. bore and 2,000 mm. stroke, running at 125 r.p.m., indicated that by using the impulse energy of the exhaust there would be at least 15 per cent. more energy available for the turbo charger. To avoid interference of the pressure waves, a double-inlet turbine was employed, one inlet being fed from cylinder No. 1 only and the other from Nos. 2 and 3. A limitation in the choice of port timing was that the engine was required to be reversible, and a compromise was reached allowing the exhaust ports to open 28 deg. before the air ports when running in the "forward" condition with an 8 deg. lead on the crankshaft, but only 12 deg. before the air ports when running astern. This limits the continuous astern rating to about five-eighths full load, but this was considered satisfactory, as astern power is generally only needed for manoeuvring.

The engine was constructed with a lever-operated reciprocating scavenge pump, and experiments were carried out on the turbo-charger (of Brown-Boveri make) in parallel with the pump, in series and alone. The second arrangement was found to be best, with the turbo-charger feeding into the scavenge pump. Alone, the turbo-charger was unable to supply enough air, and in parallel there was too much interaction. Another limitation was the requirement for a waste heat boiler to be fitted, and the back-pressure that this imposed was felt least by the series arrangement. A back-pressure of up to 18 in. of water was found to be acceptable and the exhaust temperatures did not change greatly from those of the normally-aspirated engine, there still being enough heat available for steam raising.

Supercharging can give an increase of 50 per cent. in the power output of an engine, meaning that the largest Doxford now being built will be capable of about 13,000 h.p. as against 9,000. Such an engine, of six cylinders, would weigh 555 tons. Another advantage is that a super-charged engine would require less space than a normally-aspirated engine of the same power. This would amount to about 3 ft. 6 in. in length and the difference in weight would be nearly 120 tons. One supercharged three-cylinder engine has now been in use at sea for 18 months, replacing a four-cylinder normally-aspirated engine.

USE OF HEAVY FUEL

The second main development of the Doxford engine (again in company with some others) has been the adaptation to burning heavy oils. The fuel is passed through a dual centrifuge with intermediate heating and is again heated before injection. A certain amount of corrosion occurring in the crank cases, crosshead bearings, crank pins and journals led to the development of the diaphragm engine to prevent the sulphur-bearing sludge from getting into the crankcase and contaminating the lubricating oil. Water cooling of the pistons has been abandoned, although nearly 2½ times as much oil is needed to remove the same amount of heat.

To form the diaphragm, the engine has been re-designed with a piston rod and gland box, so that the open end of the cylinder is entirely separate from the crankcase. Packing rings prevent the passage of any products of combustion which may pass the piston from entering the crankcase, and also prevent oil being carried to the cylinder on the piston rod. The space above the diaphragm is accessible for cleaning, or it may be drained continuously by a large-diameter pipe. Observation has shown that there is little sludge formation when the jacket and fuel temperatures are kept above 110 deg. F. (inlet) and 140 deg. F., respectively, but increases rapidly below these figures. Wear on liners and rings is also dependent on temperature. Existing engines can be modified and fitted with the diaphragm *in situ* if required.

Two other changes have recently been made, and these relate to the fuel-injection system, and the air starting mechanism. The fuel system which had been in use for over 30 years, used a common-rail injection, with a multi-throw pump charging a number of accumulator bottles—one for each cylinder. The fuel valve was mechanically lifted by a cam and the fuel injected into the cylinder. A simpler arrangement was, however, desired. Consideration was given to using a jerk-pump system, but this was abandoned as a much larger camshaft would be required (6 to 8 in. in diameter) and more noise would result. There would also have been difficulties with the reverse gear. Plans were therefore concentrated on an accumulator type of injection using a slow-speed pump to compress the fuel and discharge it over 120 deg. of crank angle. Timing and duration would be controlled by separate means and the fuel valve would be of the differential needle type. A small and compact system was developed on these lines and it was found the cam opening the fuel valve could be phased symmetrically with regard to top dead centre; the system would therefore operate equally well in both directions without any additional manoeuvring gear.

Arising out of this new fuel system, a new air starting system was evolved in which the direction of rotation could be chosen by pushing forward or pulling back a single control lever. The movement admits compressed air to one or other side of a rotary distributor which governs the sequential feed to the ports. This is a considerable simplification of the earlier system.

* A. Storey, "The Doxford Engine—Progress and Development." Paper presented to the North East Coast Institution of Engineers and Shipbuilders, March 23, 1956. (Abstracts.)

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CONVEYING CONCRETE

Pumping and Placing Pneumatically

Direct transport of freshly mixed concrete from the mixer to the point of placing has been achieved for some years by pumping. An addition to the plant available for this work is the Pneumatic Placer that has recently been introduced by Blaw Knox, Limited, 94 Brompton-road, London, S.W.3. It consists of three parts: the pressure cylinder and receiving hopper to be located below the mixer; the pipe line, which is 6 in. in diameter; and the discharge box to be erected above the point of delivery. The capacity of the plant is 35 cub. yard per hour and—as for conventional pumping—the delivery range is put at 1,000 ft. horizontally, or a 100 ft. vertical lift.

The pressure cylinder, shown in Fig. 1, has a capacity of 17·5 cub. ft. and each model is proved to 150 lb. per square inch. It is constructed with a receiving hopper at the top, and the lower part is fitted with a removable adaptor designed for easy coupling to the pipeline. The mixed concrete is discharged into the pressure cylinder, which is then closed by a cone valve that is kept clean, and thereby airtight, by a pneumatic surface-cleaning attachment. Compressed air from a receiver is then admitted to the cylinder through a quick-action valve and the full batch of concrete is driven through the pipeline at a speed that can be controlled by regulating the air pressure in the cylinder. An internal deflector cone prevents a core being blown through the body of the concrete, and the attention paid to the form of the pressure cylinder assists in the regular flow of a uniform mix. To enable harsh mixes to be handled, a supplementary airline through the centre of the deflector is used as a booster.

The pipeline, of 6 in. diameter, is of steel tubing, principally in 10 ft. straight lengths; also available, in order to reach a particular location, is a range of sections and bends of 1 ft., 2 ft., 3 ft. and 5 ft. length. A rubber sealing gland is used to make airtight connections between successive sections of pipe.

The discharge box, shown in Fig. 2, which illustrates the plant in use on a site where the contractors are Harry Fairclough, Limited, Warrington, has been so designed that the concrete and air are separated before delivery. A central baffle within the box causes the flow of concrete to divide into two streams which are later re-united before discharge. This slows the velocity of delivery and reduces the force of discharge, so minimising the risk of segregation. Satisfactory operation is claimed for concretes of high and low slump, but a limit of 2 in. is put on the largest size of aggregate.

Fig. 1 Pressure cylinder, with receiving hopper.

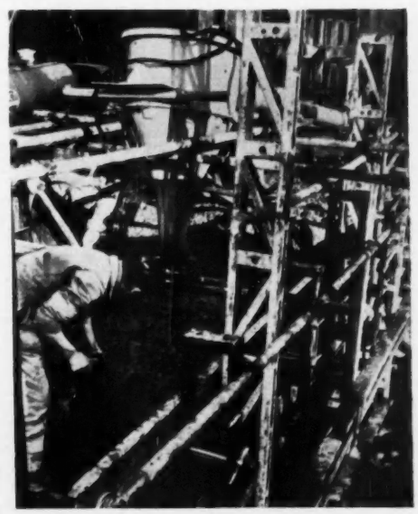
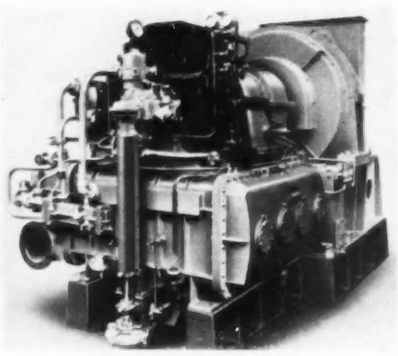


Fig. 2 Discharge box delivering concrete ready for final placing.

Figs. 1 and 2 The Blaw Knox Pneumatic Placer will convey concrete 1,000 ft. horizontally or 100 ft. vertically through a 6 in. pipeline at rates up to 35 cub. yard per hour.



Self-contained epicyclic geared direct-current 1,200 kW turbo-generator made by W. H. Allen Sons and Company for the "Empress of Britain".

"EMPRESS OF BRITAIN"

Installed Equipment

In our article last week on the Canadian Pacific Steamship Company vessel Empress of Britain, shortage of space prevented our mentioning a number of important items of equipment, including the generating plant, part of which is shown in the illustration above.

Electric Generators

Two 1,200 kW 225 volt turbo-generators made by W. H. Allen Sons and Company, and three 500 kW 225 volt Diesel generators built by the same firm, are installed for supplying current to auxiliaries, lighting and other ship's services. The turbo-generator turbines are designed to maintain the specified output when supplied with steam at 600 lb. per sq. in. and 850 deg. F. with a condenser vacuum of 28½ in. They are arranged to drive the generators through flexible couplings and epicyclic gearing. The generators are compound wound, each having a drip-proof canopy and designed for running in parallel. Three compensated 120 kVA motor alternators are installed for supplying 230 volts alternating current for cold cathode lighting (G.E.C.) and other requirements.

The ship is also equipped with two emergency National Diesel-engine driven generating sets each having an output of 165 b.h.p. 100 kW at 1,000 r.p.m. More than 100 electric motors of about 3,000 total horse-power made by Laurence, Scott and Electromotors Limited, have been installed including those for winches, pumps, and refrigerating compressors. Refrigerating equipment has been made by J. and E. Hall Limited.

Boilers

John Thompson Limited were responsible for building two steam drums for the controlled superheat boiler, each withstanding a working pressure of 650 lb. per sq. in.; and also one steam drum for the reheat boiler. The Foster Wheeler design controlled superheat boilers and the reheat boiler are each fitted with a "Weldex" bled steam air preheater (Wellington Tube Works Limited). Each heater will raise the temperature of 87,500 lb. of air per hour from 90 deg. F. to 225 deg. F. when supplied with bled steam at a pressure of 15 lb. per sq. in. gauge. This is the normal rating of the heaters; under maximum horse-power conditions a bypass is used to limit the draught loss.

Other equipment has been made by Kelvin and Hughes Limited (navigation and other instruments including echo sounder, Ralston stability and trim indicator, non-resonant standard liquid compass and an "Automajor" mechanical sounding machine); the Marconi International Marine Communication Company ("Globespan" transmitters and "Atalanta" (receivers); Decca (radar); Pye Marine Limited (loudspeaker equipment); British Insulated and Callender Cable Company (cables); Martin, Black and Company (wire ropes); Clarke, Chapman and Company (capstans and windlass); and Ransome and Marles Bearing Company (ball and roller bearings in fans, pumps, valves, motors and winches).

We regret that in our article on the Empress of Britain last week, the drawing of the funnel was incorrect; the word "blower" should have been in each case "boiler." We also omitted to mention that the overspeed trip gear fitted to the aft end of the H.P. turbine is of up-to-date "ring" type.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

BIRMINGHAM
Film Evening. Birmingham Branch. Birmingham Chamber of Commerce, 95 New-street, Birmingham. Wed., May 9, 7.15 p.m.

BRISTOL
Discussion, to be opened by G. L. Leighton. Bristol and West of England Branch. Grand Hotel, Bristol. Fri., May 11, 7.30 p.m.

HALIFAX
"Modern Fire-Alarm Equipment," by A. Cobham. Halifax Branch. Crown Hotel, Horton-street, Halifax. Wed., May 9, 7.30 p.m.

ILFORD
"Heavy Power Units in Dock Installations," by F. W. Sheppard. North East London Branch. Angel Hotel, Ilford. Mon., May 7, 8 p.m.

LEEDS
"Ultra-Violet and Infra-Red Lamps," by H. Laycock. Leeds Branch. Great Northern Hotel, Leeds. Mon., May 7, 7.30 p.m.

LUTON
Discussion, to be opened by G. C. Morgan. Luton Branch. Midland Hotel, Williamson-street, Luton. Tues., May 8, 8 p.m.

British Plastics Federation

LONDON
Discussion on whether a separate section of the Federation should be set up to cover the vacuum forming side of the industry. Meeting open to all interested persons. Tues., May 15, 11 a.m.

Chadwick Public Lecture

LONDON
"Influence of Chadwick on American Public Health," by Dr. Huntington Williams. Royal Society of Medicine, 1 Wimpole-street, W.1. Mon., May 14, 5 p.m.

Chemical Society

GALWAY
"Seaweeds and Their Utilisation," by Dr. F. N. Woodward. Chemistry Department, University College, Galway, Eire. Mon., May 7, 7.45 p.m.

Corporation of Industrial Managers

LONDON
"Impact of Automation on Management," by E. L. G. Robbins. Charing Cross Hotel, Strand, W.C.2. Mon., May 14, 7.15 p.m.* (Admission by ticket.)

Illuminating Engineering Society

LEICESTER
Annual General Meeting. Leicester Centre. Offices of the East Midlands Electricity Board, Charles-street, Leicester. Mon., May 14, 6 p.m.

LIVERPOOL
Annual General Meeting. Liverpool Centre. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Wed., May 16, 6 p.m.

Incorporated Plant Engineers

BLACKBURN
Open Meeting. Blackburn Branch. Golden Lion Hotel, Blackburn. Thurs., May 17, 7.30 p.m.

GLASGOW
"Paints in Relation to Maintenance," by T. H. Bullions. Glasgow Branch. Scottish Building Centre, 425–427 Sauchiehall-street, Glasgow. Thurs., May 10, 7 p.m.

MANCHESTER
Film on "Mechanical Handling," introduced by H. A. Collman. Manchester Branch. Engineer's Club, Albert-square, Manchester. Tues., May 8, 7.15 p.m.

NEWCASTLE-UPON-TYNE
"Incentive Bonus for Maintenance Work," by A. J. Speakman. North East Branch. Roadway House, Oxford-street, Newcastle-upon-Tyne. Thurs., May 10, 7 p.m.

ROCHESTER
"Air Conditioning in Engineering," by K. W. Dale. Kent Branch. Bull Hotel, Rochester. Wed., May 16, 7 p.m.

Institute of British Foundrymen

COVENTRY
"Investment Casting for Aircraft Engines," by D. F. B. Tedds. Coventry Section. Coventry Technical College, Coventry. Tues., May 15, 7.30 p.m.

Institute of Marine Engineers

LONDON
"The Shipping Industry," by A. Watson. Student Lecture. Mon., May 14, 6.30 p.m.*

Institute of Petroleum

LONDON
"Recent Oil Development in France," by P. S. Hirtz. Wed., May 9, 5.30 p.m.*

Institute of Road Transport Engineers

CARDIFF
"The Commer T.S.3 Two-Stroke Diesel Engine," by E. W. Coy. South Wales Group. South Wales Institute of Engineers, Park-place, Cardiff. Fri., May 11, 7 p.m.

Institution of Civil Engineers

LONDON
"The Construction of Middleton Connecting Sewer in North Manchester," by E. H. Collier. Public Health Division. Tues., May 8, 5.30 p.m.*
"The Allowable Settlements of Buildings," by Professor A. W. Skempton and Dr. D. H. MacDonald. Structural and Building Division. Thurs., May 10, 5.30 p.m.*
James Forrest Lecture on "Marine Physics," by Dr. G. E. R. Deacon. Tues., May 15, 5.30 p.m.*

Institution of Electrical Engineers

LONDON
"Ship Stabilisation: Automatic Controls, Computed and in Practice," by J. Bell. Measurement and Control Section. Tues., May 8, 5.30 p.m.*
"Time Sharing as a Basis for Electronic Telephone Switching: A Switched Highways System," by L. R. F. Harris. Radio and Telecommunication Section. Wed., May 9, 5.30 p.m.*
Discussion on "An Elementary Presentation of the Principles of Magnetism and Electromagnetic Induction," with demonstrations, to be opened by Professor K. A. Hayes. Education Discussion Circle. Mon., May 14, 6 p.m.*
Annual General Meeting and Film Evening. London Graduates' and Students' Section. Mon., May 14, 6.30 p.m.*
"Mine Locomotives," by T. E. Green. Utilization Section. Tues., May 15, 5.30 p.m.*

BIRMINGHAM
"Problems of Hydro-Electric Design in Mixed Thermal-Hydro-Electric Systems," by T. G. N. Haldane and P. L. Blackstone. South Midland Centre. James Watt Memorial Institute, Great Charles-street, Birmingham. Mon., May 7, 6 p.m.

DUNDEE
Annual General Meeting. North Scotland Sub-Centre. Electrical Engineering Department, Queen's College, Dundee. Thurs., May 10, 7 p.m.

EDINBURGH
Annual General Meeting. South East Scotland Sub-Centre. Carlton Hotel, North Bridge, Edinburgh. Tues., May 8, 7 p.m.

Institution of Engineering Designers

NEWCASTLE-UPON-TYNE
Annual General Meeting, at 6.15 p.m. Annual Dinner, at 7.30 p.m. North East Branch. Crown Hotel, Clayton-street, Newcastle-upon-Tyne. Fri., May 18.

Institution of Mechanical Engineers

LONDON
Discussion on "What is Lubrication Engineering?" Lubrication Group. Wed., May 9, 6.45 p.m.*
"The Influence of the Gas-Turbine Axial-Flow Aero Engine on Blade Manufacturing Methods," by R. R. Whyte. Industrial Administration and Engineering Production Group. Fri., May 11, 5.30 p.m.*
Annual General Meeting. London Graduates' Section. Wed., May 16, 6.30 p.m.*

Institution of Mining and Metallurgy

LONDON
Annual General Meeting. Part I, Report of Council. (This part open to Corporate and Non-Corporate Members only), at 4 p.m. Tea at 4.30 p.m. Part II. Presidential Address, by Professor C. W. Dannatt, at 5.15 p.m. Geological Society, Burlington House, Piccadilly, W.1. Thurs., May 17.

Institution of Production Engineers

BIRMINGHAM
Film Evening. Birmingham Graduate Section. James Watt Memorial Institute, Great Charles-street, Birmingham. Tues., May 8, 7 p.m.

WOLVERHAMPTON
"The Use of Air-Operated Fixtures in Mass Production," by J. F. Smith. Wolverhampton Graduate Section. Wolverhampton and Staffordshire Technical College, Wulfruna-street, Wolverhampton. Wed., May 16, 7.30 p.m.

Iron and Steel Institute

LONDON
Bessemer Centenary Lecture by James Mitchell. Royal Institution, Albemarle-street, W.1. Tues., May 15, 6.30 for 6.45 p.m. Admission by ticket (no charge).

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it is understood that tea is available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
British Plastics Federation, 47–48 Piccadilly, London, W.1. (REGent 4681.)
Chadwick Trust, 90 Buckingham Palace-road, London, S.W.1. (SLOane 5134.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Corporation of Industrial Managers. Apply to Mr. C. J. Hatter, 38 Chalkhill-road, Wembley Park, Middlesex. (ARNold 8863.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham. (Solihull 3021.)
Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester 3. (Blackfriars 6178.)
Institute of Marine Engineers, 85 The Minories, London, E.C.3. (ROYal 8493.)
Institute of Petroleum, Manson House, 26 Portland-place, London, W.1. (LANgham 2250.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineering Designers, 38 Portland-place, London, W.1. (LANgham 8847.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Mining and Metallurgy, 44 Portland-place, London, W.1. (LANgham 3802.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Iron and Steel Institute, 4 Grosvenor-gardens, London, S.W.1. (SLOane 0061.)
King's College (University of London), Strand, London, W.C.2. (TEMple Bar 5454.)
Newcomen Society, Science Museum, Exhibition-road, London, S.W.7. (KENsington 1793.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal Institution, 21 Albemarle-street, London, W.1. (HYDe Park 0669.)
Royal Meteorological Society, 49 Cromwell-road, South Kensington, London, S.W.7. (KENsington 0730.)
Royal Society, Burlington House, Piccadilly, London, W.1. (REGent 3335.)
Royal Society of Arts, John Adam-street, Adelphi, London, W.C.2. (TRAfalgar 2366.)
Royal Statistical Society, 21 Bentinck-street, London, W.1. (WELbeck 7638.)
Society of Engineers, 17 Victoria-street, London, S.W.1. (ABBEY 7244.)
Society of Instrument Technology, 184 Sherwood Park-road, Mitcham, Surrey. (POLlards 3620.)
Women's Engineering Society, 25 Foubert's-place, London, W.1. (GERrard 5212.)

al General Meeting:
dential Address, by Dr. H. H. Burton; and Ninth Hatfield orial Lecture on "The Fracture of Metals," by Professor F. Mott. Royal Institution, Albemarle-street, W.1. May 16, 9.15 a.m.
us papers for discussion; and colour film "Steel Road." rosvenor-gardens, S.W.1. Wed., May 16, 2.30 p.m.
Grosvenor House, Park-lane, W.1. Wed., May 16, 7.30 p.m.
us papers for discussion. 4 Grosvenor-gardens, S.W.1. ., May 17, 9.45 a.m. and 2.15 p.m.

King's College London

LONDON
ecial University Lectures in Civil Engineering. Course four lectures, by Professor Hjalmar Granholm. Two on periments and Experiences with High-Grade Corrugated einforcing Steel," on Mon., May 7, and Tues., May 8, at 5.30 p.m.; and two on "Problems Concerning Pile Driving nd Foundations on Piles of Timber, Concrete and Steel in weden," on Wed., May 9, and Fri., May 11, at 5.30 p.m. Tickets not required.

Newcomen Society

LONDON
Dickinson Memorial Lecture on "Iron and Steel Production in Ancient and Medieval China," by Dr. Joseph Needham. Wed., May 9, 6 p.m.

Royal Aeronautical Society

LONDON
All-Day Discussion on "Problems of Superonic Flight." "Propulsion," by A. V. Cleaver; "Aerodynamics," by P. J. Duncton; "Structures," by D. J. Farrar; and "Cabin Conditions, Controls, etc." by H. H. Gardner. Institution of Civil Engineers, Great George-street, S.W.1. Wed., May 9, 10 a.m.
"Medical Aspects of Flight Comfort and Efficiency," by Dr. A. Buchanan Barbour. Tues., May 15, 7 p.m.
Forty-fourth Wilbur Wright Lecture by Sir William S. Farren. Royal Institution, Albemarle-street, W.1. Thurs., May 17, 6 p.m.*

Royal Institution

LONDON
"The Exploration of the Upper Atmosphere," by Professor H. S. W. Massey. Fri., May 11, 9 p.m.
"The Structure of Metals as Seen under the Microscope," by Professor Cyril S. Smith (University of Chicago). Fri. May 25, 9 p.m.

Royal Meteorological Society

LONDON
Various short papers. Wed., May 16, 5 p.m.*

Royal Society

LONDON
"Research in the Plastics Division of Imperial Chemical Industries, Ltd.," by Dr. J. C. Swallow. Thurs., May 17, 4.30 p.m.*

Royal Society of Arts

LONDON
"Automation," by the Earl of Halsbury. Wed., May 9, 2.30 p.m.

Royal Statistical Society

LONDON
"Basic Statistical Concepts Illustrated on Tests for Randomness, with Special Reference to the Classical Problem of Points on a Line," by Dr. F. N. David. Study Section. Lighting Service Bureau, 2 Savoy-hill, W.C.2. Wed., May 9, 6 p.m.

Society of Engineers

LONDON
"Oil-Fired Packaged Boilers, and Their Development and Application in the United Kingdom," by D. F. Brice. Geological Society, Burlington House, Piccadilly, W.1. Mon., May 7, 5.30 p.m.*

Society of Instrument Technology

MANCHESTER
Annual General Meeting. "Chemical Balances," by Dr. G. F. Hodsman. Manchester Section. College of Technology, Sackville-street, Manchester. Tues., May 8, 7.30 p.m.
NEWCASTLE-UPON-TYNE
Annual General Meeting. Newcastle Section. Stephenson Building, King's College, Newcastle-upon-Tyne. Wed., May 9, 7 p.m.

Women's Engineering Society

LONDON
Discussion on "Mining Machinery." London Branch. Hope House, 45 Great Peter-street, Westminster, S.W.1. Mon., May 14, 7 p.m.*

MECHANICAL HANDLING

1—SHOVELS AND CRANES

On Wednesday next the biennial Mechanical Handling Exhibition, organised by the journal *Mechanical Handling*, will be opened by Sir Miles Thomas at Earl's Court, London, and will continue until Saturday, May 19. This year for the first time, an International Convention is to be held in conjunction with the exhibition. There will be seven sessions, each commencing at 3 p.m., and the following papers are to be presented. On Thursday, May 10, Mr. F. G. Woolland (Great Britain) will speak on "Mechanical Handling—Prospects and Problems"; on Friday, May 11, Lieutenant-Colonel P. A. J. Pernu (Ceylon) on "Some Handling Problems in Ceylon"; on Monday, May 14, Dr. F. Hegner (Switzerland), on "Modern Methods of Co-ordination of Interplant Handling," followed by a film on palletisation; on Tuesday, May 15, Mr. H. E. Stocker (U.S.A.), on "Mechanical Handling in International Commerce—Conclusions from 35 Years of Experience"; on Wednesday, May 16, Mr. Douglas A. Gillespie (Canada), on "The Field for British Equipment in Canada and the United States"; on Thursday, May 17, on "Mechanical Handling in Australia"; and on Friday, May 18, Dipl. Ing. Gert Salzer (Germany), on "The Solution to Materials Handling Problems in Germany."

In the exhibition proper, some 250 manufacturers will be displaying their latest developments in lifting, loading, conveying, screening and storage equipment, and in ancillaries such as transmission belting, chains, and gears; hydraulic and pneumatic systems; prime movers; electric motors, batteries and switchgear; and electronic control equipment, etc. The fields of application will range from vast coalmining installations to simple portable handling tools for the farmer and systems for the "mechanical handling" of office paper work. From the many interesting exhibits we have selected a few representative items, most of which will be shown in public for the first time.

HYDRAULIC LOADING SHOVELS

Typical of the versatility of modern handling equipment are the two Loadmaster Diesel-driven hydraulic loading shovels and light excavators to be shown by the Chaseside Engineering Company Limited, Station Works, Hertford. The Loadmaster 600, with front-wheel drive, Fig. 1, is recommended for fast stockpiling on firm ground and also for handling bulk materials on industrial premises and in confined areas. In addition to the wide range of interchangeable scoops which can be used with this machine, there is now available a new fork-lift attachment, to be shown at the exhibition for the first time. It is capable of lifting 3,000 lb. at 24 in. centres to a maximum height of 10 ft.

Fig. 1 Loadmaster 600 front-wheel drive hydraulic shovel with 3,000 lb. fork-lift attachment. Chaseside Engineering Co. Ltd.

Fig. 2 Swing-loading shovel, used also with fork-lift attachment. Power Handling Ltd.

The rear-wheel drive Loadmaster 500, which has power-assisted steering, will also be shown with a range of new attachments. The latter include a 7 ft. 6 in. bulldozer blade, a 1 ton crane hook, both readily and quickly attached to the scoop, a fork scoop with a hydraulically operated claw for handling bulk timber, scaffold poles, etc., and a selective rock scoop.

Power Handling Limited, Bingley, Yorkshire, will show their ¾ cub. yard swing-loading shovel, Fig. 2, with a 1 ton fork-lift attachment. This shovel, it is stated, is the first British-made hydraulically-operated pneumatic-tyred loading shovel with a swinging jib. The radius of swing, approximately 185 deg., allows the bucket to be discharged to either side without any movement of the base machine. The shovel is powered by a Fordson Diesel engine.

RAIL AND ROAD CRANES FOR HEAVY DUTY

Three new cranes are to be shown by Steels Engineering Products Limited, Sunderland. Fig. 3 illustrates their Atlantis rail-mounted full-circle-slewing Diesel-electric crane designed for operation by one man. It has a lifting capacity of 20 tons at 10 ft. radius with a 30 ft. jib. The crane has four motions—hoisting, derricking, slewing and travelling—each powered by a separate electric motor which are energised by direct current from a variable-speed generator coupled to a Diesel engine. The power unit is mounted on the rear of the superstructure. The crane travels on eight single-flange steel-tyred rail wheels arranged in double bogies, and operates on 4 ft. 8½ in. gauge track. The crane is full-circle-slewing, all operations being controlled from the driver's cockpit on the revolving superstructure. In the event of a power failure electro-mechanical brakes are applied automatically to the hoisting, derricking and slewing motions. Foot-operated air pressure brake shoes act on all eight wheels and a handbrake may be applied mechanically. Automatic self-resetting limit switches are fitted to the hoisting and derricking motions to prevent operation beyond the prescribed limits.

Included among the optional equipment are such features as the Coles B & A safe-load indicator; spring buffers; derailing beams; grabs and magnets. The jib, which is of lattice construction, may be lengthened up to 80 ft. by the addition of jib extensions.

Steels Engineering Products will also show their new heavy-duty Dreadnought truck-mounted full-circle slewing Diesel-electric crane. The version exhibited will have a lifting capacity of 11 tons at 15 ft. radius with an 80 ft. jib, but the standard jib length is 30 ft., giving a lifting capacity of 20 tons at 10 ft. radius. On the long-jib version shown, non-standard dynamic braking is fitted to allow an extra margin of safety.

Fig. 3 Atlantis full-circle slewing 20 ton rail-mounted crane. Steels Engineering Products, Ltd.

Their third new machine is the self-propelled S.710s Ajax Diesel-electric crane designed to lift 5 tons at 10 ft. radius with a 30 ft. centre jib; it has full-circle slewing, is one-man operated and fully mobile. The version to be shown is fitted with a 60 ft. centre jib, giving a lifting capacity of 2 tons at 15 ft. radius and is equipped with a hook-on self-dumping grab of 15/12 cub. ft. capacity.

FAST MOBILE CRANE

Ransomes and Rapier Limited, P.O. Box 1, Waterside Works, Ipswich, Suffolk, will show for the first time their Rapier 7 fast standard mobile crane, Fig. 4, designed for road travelling between railway depots, road-haulage systems and industrial undertakings. It can be driven at normal road-traffic speeds, and can operate in congested areas inaccessible to lorry-mounted cranes. The crane is exceptionally manoeuvrable and, in effect, provides full-circle slewing on its road wheels.

Fitted with the standard jib, the Rapier 7 crane will lift a 7½ ton load at a rate of 20 ft. per minute to a height of 20 ft. 10 in. above the ground with a 4 ft. 6 in. outreach, or a 3¼ ton load at a rate of 28 ft. per minute to 8 ft. 8 in. above the ground with an outreach of 11 ft. 4 in. Short and long jib extensions are available, the latter giving a maximum lift of 3¼ tons to 29 ft. 10 in., with a 10 ft. outreach, or 1½ tons to 11 ft. 1 in. with a 22 ft. outreach. The full derricking range can be accomplished in 16 seconds.

Fig. 4 Rapier 7 fast standard mobile crane for road haulage. Ransomes and Rapier Ltd.

The crane is driven by a Perkins P.6 70 h.p. Diesel engine through a Borg and Beck clutch and a gearbox giving three forward and three reverse speeds with a single gear-change lever, thence through roller-chain reduction gearing to a two-speed axle, the axle gear change being operated by vacuum pump. With the standard reduction gearing the crane has a top speed of 16 m.p.h.; an alternative gearing is available to give a maximum speed of 20 m.p.h. Unloaded the crane can climb a 1 in 5 gradient and, fully loaded, a 1 in 8 gradient. Power-assisted steering is provided and the vehicle has a turning circle of 14 ft. radius. Separate motors provide for the hoisting and derricking motions, each motor being fitted with a self-adjusting magnetic brake. Regenerative braking can be effected by switching off the engine with the appropriate control in the " on " position.

CRANE WITH FOUR-WHEEL STEERING

George Cohen Sons and Company, Limited, Wood-lane, London, W.12, will show their new Jones KL 33 crane which they introduced last December. This 3 ton capacity machine, illustrated in Fig. 5, is built on the unit-construction principle and is powered by a two-cylinder air-cooled Petter Diesel engine. A wide choice of mountings is available, and two examples will be exhibited. One of these is a pneumatic-tyred chassis giving four-wheel differential drive and four-wheel steering. The KL 33 is the first mobile crane to be offered with this steering arrangement as a standard alternative. Thus equipped, the crane's manoeuvrability is exceptional, the turning circle being reduced in radius to 13 ft. The wide range of jibs available includes swan-neck, channel and sectional lattice types, as well as a 16 ft. 9 in. cantilever design with hydraulic derricking equipment.

A 6 ton capacity Jones KL 66 crane is also now available with four-wheel steering, giving greatly increased manoeuvrability when working in confined spaces, and with a hydraulically derricked cantilever jib. Delicacy of control is a feature of the KL 66 machine. It can be fitted with jibs up to 65 ft. long, and is available on various mountings.

To be continued

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TRAINING BOILER OPERATORS

Two short films, which are to be followed by three more, have been produced by the National Industrial Fuel Efficiency Service, 71 Grosvenor-street, London, W.1. to supplement the Services' course in training boiler operators. Both run for about ten minutes, and the first shows how and why coal can vary in quality. The second shows the four main sources of heat loss in the furnace, and makes suggestions how operators can help to overcome them.

THERMONUCLEAR POWER

Preliminary steps in the application of thermonuclear energy to power production were reported in a lecture delivered by Academician I. G. Kurchatov at Harwell on April 25. Research in the Soviet Union related to this subject was discussed in the second part of the lecture, the beginning of which was devoted to Russian plans for the building of nuclear power stations. Much of this first part had already been covered at Geneva last August.

The second half was an account of some important experiments designed to achieve a fusion reaction by passing extremely large pulsed electric currents through tubes containing various gases, and in particular deuterium. The possibility of this is well-known and has been the subject of experiments in several countries, including the United Kingdom. The Russians have carried these experiments to a stage when they have been able to achieve temperatures of the order of about one million deg. C., the threshold at which the fusion reaction may be expected to begin to take place. The currents involved ranged from 100,000 to two million amperes and the greatest instantaneous release of power was as much as 40 million kW. The use of these high currents served not only to raise the temperature of the gas to a very high value but to permit control of the hot charged gases by magnetic forces produced by the current; this was necessary since the materials of the tube walls and the electrodes could not withstand contact with the hottest parts of the gas without melting. During heating, fluctuations in the thickness of the gas column occurred and this added to the difficulty of protecting the walls; the problem was to prevent the gas touching the tube when the fluctuations occurred.

An indication of the achievement of fusion of two deuterium atoms would be the emission of neutrons by the discharge. The Russian experiments have indeed led to the discovery of neutrons from the discharge but careful work by them over several years has shown that, in the experiments so far conducted, these neutrons do not arise from a fusion reaction but from an unexpected set of changes in the nature of the gas discharge channel. Experiments were carried out not only on deuterium (heavy hydrogen) but also on ordinary hydrogen, helium and other gases. The length of the spark gap was varied from several centimetres up to two metres, and various pressures and electrode were used.

Background Notes

A number of countries are investigating the possibilities of obtaining economic power from controlled thermonuclear reactions. These reactions can take place for example, when two deuterium nuclei collide with sufficient energy. The products of the reaction carry away with them some 40 times as much energy as that required to speed up the deuterium. However, in the conventional laboratory experiment less than one in a hundred thousand of the bombarding particles are effective, the remainder give up their energy to the electrons present and not taking part in nuclear fusion. The overall efficiency of the process is therefore very low. To make the process efficient it is necessary for a large fraction of the nuclei to take part in the reaction. This condition would be satisfied if the temperature of the atoms involved could be raised to something exceeding several million degrees. If a controlled thermonuclear reaction is to be achieved, two main problems must be solved: it is necessary to bring a mixture of the light elements to the above temperature, and to maintain this temperature long enough for the energy released in nuclear fusion to be greater than that required to heat the fuel.

Fig. 5 Jones KL 33 20 ton crane, constructed on the unit principle. George Cohen Sons and Co. Ltd.

In Parliament

ASWAN HIGH DAM

The view was put forward in the House of Commons recently that the construction of the high dam at Aswan was contrary to the general interests of all the surrounding riverine countries except Egypt, could endanger Britain's future interests in East Africa, and was economically and hydrologically wasteful compared to alternative projects. In answer to Mr. H. C. P. J. Fraser (Conservative), who raised the matter, Mr. Anthony Nutting, the Minister of State for Foreign Affairs, stated that the British Government had entered into international negotiations for financing the Aswan High Dam because, after careful study, they believed the project to be technically sound and of great importance to the welfare of the Egyptian people. Mr. Fraser suggested that the interests of British people in Kenya and elsewhere were more important; that the £10 million involved could well be expended on Sir Alexander Gibb's project for irrigation in Kenya; and that the high dam project would cost £350 million, while the alternative proposed by other engineers would cost only £150 million.

Mr. Nutting replied that the British Government were in negotiation with the Egyptian Government and the International Bank, and considered that the high dam project was a reasonable one, provided that reasonable terms and the necessary agreement upon it could be obtained. As to the protection of British colonial interests, the statement of the Colonial Secretary, Mr. Alan Lennox-Boyd, on March 21 last, that the British Government had no intention of abdicating their rights in the matter, still stood.

OWEN FALLS SCHEME

Mr. C. L. Hale (Labour) said that when the Owen Falls scheme was initiated and approved in 1946, it was presented to the House of Commons as constituting part of a very large scheme of development in East Africa. The scheme was to include the reclamation of the mud flats of the Blue Nile and a project for developing navigation towards the Mountains of the Moon. It was regarded as constituting one of the greatest schemes of colonial development and as being very much needed in an area suffering from acute poverty. Was it to be understood that the Government now rejected that scheme in favour of one to assist the Egyptians to maintain their standard of life and establish more power and influence in the Sudan?

Mr. Nutting said that this was not so, and, in answer to questions by Captain C. Waterhouse (Conservative), stated that the facts were that no agreement had been reached with Egypt. The British Government was negotiating with the Egyptian Government and the results of that negotiation, and of negotiations between the Egyptian government and the International Bank would depend upon the prior concurrence of the Sudanese Government.

NILE WATERS AGREEMENT

Later, Mr. Fraser asked the Foreign Secretary whether, in view of the changed political and economic circumstances, he would press for a review of the Nile Waters Agreement, 1929, and consequential agreements, and, at the same time, approach other interested Governments with a view to setting up an international authority for the Nile valley. Mr. Fraser said that there appeared to be complete disagreement between the Governments of Egypt and the Sudan, and he felt that, before the Aswan Dam project was put into operation, Great Britain should see that the whole matter was reorganised and that there should be a single authority for the whole Nile valley.

Mr. Nutting agreed that a review of the Nile Waters Agreement was needed and said that essential preliminary was a settlement of outstanding difficulties between the Egyptian and Sudanese Governments. He understood that the discussions between them were proceeding. There had been consultations with the Governments of Uganda and Kenya. He informed Mr. James Johnson (Labour) that the question of Ethiopian interests should be raised on another occasion. Mr. Fraser gave notice that, in view of the interest in this matter, it was his intention to raise it again in an adjournment debate.

It may be noted that, in his statement on March 21, Mr. Lennox-Boyd informed Mr. Fraser that the waters of Lake Victoria and Albert formed part of the Nile system and, as such, came within the scope of the Nile Waters Agreement of 1929. The East Africa Royal Commission had seen no reason why it should not be possible, in accordance with the principles of that agreement, to negotiate on behalf of Kenya, Tanganyika and Uganda, for an equitable share of the waters of the Nile. Mr. Lennox-Boyd said that he agreed with the Commission's view. He added that the Governments of Egypt and the Sudan had recently been informed that the British Government formally reserved their rights to negotiate with them on behalf of these three territories for an agreed share of the waters of the Nile.

International Atomic Energy Agency

Information was sought by Mr. John Biggs-Davison (Conservative) as to Great Britain's commitments under the United Nations' charter for the establishment of an international agency for atomic energy, and Mr. A. Henderson (Labour) asked the Foreign Secretary for a statement on the progress of the recent Washington conference regarding the peaceful uses of atomic energy. In reply, Mr. Nutting said it would be noticed from the communiqué issued after the final meeting of the Washington Negotiating Group on April 18 that a draft statute for the creation of such an agency as Mr. Biggs-Davison mentioned had been adopted by the Group. Copies of that draft statute would be placed in the library of the House of Commons as soon as available.

The Minister assured Mr. Biggs-Davison that all proposals for setting up an international agency for atomic energy would be strictly scrutinised from the point of view of Commonwealth interests and the vital importance to the Commonwealth of developments in the use of nuclear power.

In answer to Mr. Henderson, the Minister said he considered that the fully-effective operation of a peaceful nuclear agency would depend to some extent upon the fulfilment of a certain amount of nulcear disarmament. He did not know whether that matter was in President Eisenhower's mind when he brought forward his proposal for the establishment of an international agency, but the statute of the agency contained controlling powers to enable it to ensure that atomic energy which was purveyed for peaceful purposes was not diverted to military uses.

Uranium and Plutonium Supplies

Answering Mr. R. Moss (Labour), who asked for an estimate of the amount of uranium 235 and plutonium which could be made available for use in nuclear reactors constructed by British firms at home and abroad during the next few years, Mr. R. A. Butler, the Lord Privy Seal, said that supplies of these elements were limited and had to be proportioned between defence and civil requirements. At the same time, he understood from the United Kingdom Atomic Energy Authority that it expected to be able to meet the reasonable needs of industry as they occurred.

Royal Navy Suggestions Scheme

In a written answer, Mr. S. Wingfield Digby, Civil Lord of the Admiralty, told Mr. Graham Page (Conservative) that the Admiralty had operated an organised suggestions scheme for nearly half a century. Industrial staffs were encouraged individually, and through joint production committees, to make suggestions for improving efficiency. Local awards committees could make awards of up to £25, and higher amounts might be authorised for suggestions of special merit. In addition, all members of the naval service were encouraged to make suggestions for improving equipment and these, also, might result in awards being granted. Suggestions by non-industrial staffs for improving office equipment or organisation were considered by Whitley committees and notes were made on staff records when worthwhile suggestions were adopted. During the last two financial years for which statistics were available, about 800 suggestions and inventions had been considered. Over one-half of these had been adopted, but it was not possible to assess the amount of savings which had resulted.

Honours Graduates for Defence

The Minister of Defence was asked by Mr. Arthur Skeffington (Labour) what action had been taken to implement the recommendation of the Advisory Council on Scientific Policy that the Services' requirements of first and second-class honours graduates for certain posts in the active forces should be reviewed to see whether the qualifications demanded were justified. In a written answer, Sir Walter Monckton said that the requirements of the Services for men with those qualifications were being kept under review. With the increasing complexity of weapons and techniques, however, it was unlikely that the claims of the Services would diminish.

Post Office Engineers and Scientists

Replying to Mr. Austen Albu (Labour), who inquired as to the numbers of graduate engineers and scientists in the employ of the Post Office, Mr. C. J. McCall Alport, the Assistant Postmaster-General, said that there were at present 375 graduate engineers and 73 graduate scientists so engaged. In addition, 741 engineers and scientists in the Department were either corporate or graduate members of recognised professional institutions.

Technical Education Programme

Mr. T. F. Peart (Labour) inquired as to the changes being made in the Government's programme for the development of technical education, in view of the recent economy measures. He was told by Sir David Eccles, the Minister of Education, that the Government's plan for technical education was a very special case and would not be involved in the immediate review of expenditure for the financial year 1956-57, as outlined by the Chancellor of the Exchequer in the Budget debate.

Science Libraries

The Chancellor of the Exchequer was asked by Mr. L. J. Callaghan (Labour) what sums he proposed to make available for the establishment of a National Reference Library of Science and a lending library, in view of the recent report of the Scientific Advisory Council. Mr. Harold Macmillan said that £2,500 would be provided during the current year for the purchase and binding of scientific periodicals as a beginning to the lending library. A further £10,350 had been included in the estimates for the purchase of books and periodicals for the Patent Office Library. That library would eventually form the basis for the Reference Library. As to capital expenditure for buildings, the position remained as stated by Mr. J. R. Bevins, the Parliamentary Secretary to the Ministry of Works, on November 1, 1955. Mr. Bevins stated on that occasion that the proposals for improved scientific libraries referred to in the Eighth Annual Report of the Advisory Council on Scientific Policy were then under consideration by the Departments concerned. The projects would involve considerable capital expenditure and the Reference Library Scheme was necessarily bound up with wider questions involving the Patent Office. He regretted that he was not able to make any further statement for the time being.

THE HUMAN ELEMENT

Engineering union start preliminary discussions for further wage claims—The implications of automation—Efficient use of manpower—Effect of fluctuating motor-car output—Interest (and lack of interest) in trade unions—Unemployment payments for short-time workers.

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The A.E.U., Wages and the 40 hour Week

It takes a delegate conference to make a serious attempt at having your cake and eating it. Last week, the A.E.U. opted for higher wages and the 40 hour week. The president had already referred to the establishment of the 40 hour week without reduction of pay as a means of off-setting any ills which automation might bring, and in due course the union, after a somewhat desultory debate, decided that a claim for "a substantial wage increase" should go to the employers.

Demands of this sort could make sense only if there were an assured large increase in productivity in the engineering industry in 1956. If a demand for higher wages, just after a big award has recently come into force, is to be met by the industry it can hardly trim its sails at the same time to the 40 hour week and endless negotiations about redundancy. This last point is discussed in the next note. But even in its most simplified form, namely, that a higher claim is tied to higher productivity, it begs the question of how that productivity is going to be achieved in a year when the Government are pursuing a policy of deflation and export markets are becoming harder to hold. The union will no doubt argue that there should be no such policy. The fact remains, however, that there is this policy and that the engineering industry cannot pay higher wages out of profits which it should have had the chance to earn but did not.

Nothing much is likely to happen before the autumn on this matter. Government economic policy and the state of export markets will therefore have several months of further experience before formal discussions of this claim can begin. By then, economic facts may add a dash of sobriety to trade union ardour.

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A.E.U. and Automation

A confused debate at the annual delegate conference of the Amalgamated Engineering Union at Eastbourne last week produced a mischievous resolution which was carried under Communist auspices. The subject was automation. Confusion set in when a good many of the delegates found it difficult to differentiate between automation and mechanisation. Mr. R. Openshaw, in his retiring presidential address, had already alluded to automation and made it clear that he favoured the sharing in the benefits of automation by the workers. Less conciliatory views had been expressed the day before at Coventry.

On the second day of the conference, however, the Communists were able to commit the union to the slogan "no automation without consultation" and to the resolution that workers displaced by automation should be retained in employment until other work could be found for them. Later, against the advice of the executive, a resolution (inspired from the same source) agreed to shop stewards resisting redundancy at the point of production. This is an important strategic gain for the Communists for it gives a measure of independence at shop floor level in taking action against redundancy—a word which can take on a variety of hues and interpretations to suit the convenience of anyone bent on making trouble.

This is a setback for responsible trade union leadership. The lesson must not be lost elsewhere. Operatives have become much more rational in recent years at the sound of the word "mechanisation" and they have received many benefits from the increased use of machinery. But "automation" is (to them) vaguer, more sinister and newer. It can be made to conjure up the emotion-charged word "redundancy." It is becoming urgent to give the word a precise connotation as between one industry and another. If this is not done, it will stir up mischief before it has had a chance to prove that it can bring benefits.

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Restrictive Labour Practices

We now have an official statement on restrictive practices operated by workers. Among the momentous decisions reached at the recent meeting of the National Joint Advisory Council (on which representatives of the British Employers' Federation, the T.U.C. and the nationalised industries sit under the chairmanship of the Minister of Labour) was that "restrictive labour practices" was not a very nice phrase. Henceforth this will be referred to as "the efficient use of manpower." All industries are to be asked to tackle this problem with energy and thoroughness. But there will be no legislation. Mr. McLeod said that the restrictive practices of labour were not of the same kind as those of employers, and could not therefore be dealt with in the same way. Only die-hards will quarrel with the Minister; but why call these practices efficient "use" of manpower if they are operated by the very men who should be efficiently used?

In no country is Napoleon's maxim—that "there are no bad privates only bad generals"—more widely recognised than in the United States, and nowhere is productivity so high. But we have in this country over a century of tradition based on fear of unemployment and on lack of confidence between employers and employees. Yet in some companies the interests of both are thought by both to be identical: progress, growth and profitability. Often it is because they are identical, through shareholding or profit sharing. The country's need is that an *esprit de corps* should prevail and good leadership by management be matched by good leadership by the unions and the shop stewards. Too often all three are found wanting. This is a matter for local action, factory by factory, shop by shop, not for national agreements, pious resolutions or legislations.

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Lightning Strike at Coventry

Five thousand production workers employed on the manufacture of agricultural tractors by the Standard Motor Company at their Banner Lane factory in Coventry, and six thousand workers on car production at the Canley Car Works, went on strike last Friday in protest against what their representative claimed to be unilateral action by the management of the company.

The shop stewards at Banner Lane have been informed that men would be laid off next month because of the change-over of a tractor model. The original intention was that a large proportion of the men would be absorbed on car production, but the falling sales of some models has made this impossible. The shop stewards therefore requested that short-time working should be introduced, coupled on a two-and-three shift basis, to avoid laying off anyone. This the management considered impracticable. The shop stewards committee said that the management intend to lay off 3,500 men, a thousand more than originally intended, for periods of up to four months and claim they have not been consulted. Efforts are being made to get support from dockers and from the other large car firms: "preparations have been made for a long struggle."

The problems of fluctuating output which have been with the motor industry for half a century are likely to prove hard to solve in post-war Britain. Before the war, lay-offs for model changes and during the off-season were accepted as normal, as they should be. The Coventry shop stewards' new move may have an effect on the profitability of motor vehicle manufacture which will be very hard to counter. For no one has yet discovered how to even out car sales or how to stock cars effectively.

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Poll of Trade Unionists

Of the membership of a group of American trade unions, 80 per cent. consider that their union dues are a good investment. This is one of a large number of opinions which have come out of a poll taken by a research group at the University of Minnesota recently. About 1,250 trade union members from several unions in four different States were approached. Of these, 280 were local union officials and shop stewards and just over 1,000 were ordinary members. Slightly less than 50 per cent. were skilled workers. The remainder were mostly unskilled operatives, clerks and shop assistants—in that order of size of group.

Asked how often they attended meetings, 211 said "Never" and 308 said "One in four." Only 67 attended about 75 to 100 per cent. of them. One of the main reasons for union loyalty was protection against favouritism on the job. Most of those answering thought that their local union business was reasonably conducted. One point of interest emerging from the poll was the concern to get more help from national organisations for educational work. Among the rank and file, as many as 55 per cent. thought that their union spent too much time and money on political action. As might be expected, the union officials polled a smaller affirmative percentage on this one, but it was still as high as 35 per cent.

By and large, the picture emerging is one which would be recognisable on this side of the Atlantic. Union members appear to be most concerned for what they can get out of their membership on the job. They are tolerant of their officials and easy going, even apathetic, about how and by whom the actual union organisation and its business are run.

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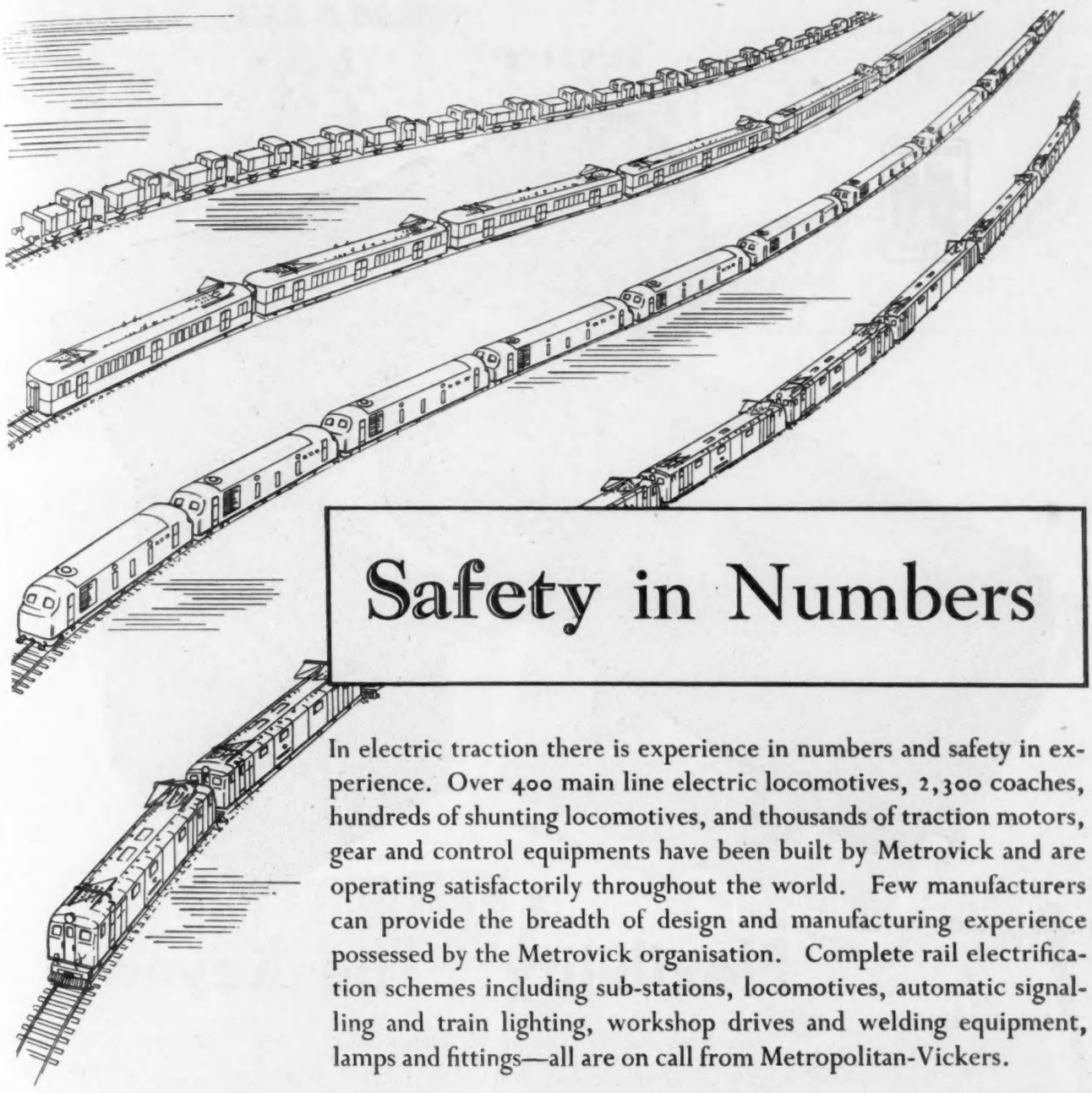
Pay for the Idle Day

A worker placed on a four-day week is entitled to receive unemployment benefit for the day on which he is not required by his employers. The National Insurance Commissioner, Judge Sir David Davies, gave this ruling on the two test cases heard last week. He allowed the appeal of the Transport and General Workers Union against an adverse ruling by the Insurance Officer in respect of a claim for unemployment benefit by an employee of Standard Motors, and he dismissed the appeal of the Insurance Officer in respect of a favourable decision on the claim by an employee of the Lockheed Hydraulic Brake Company.

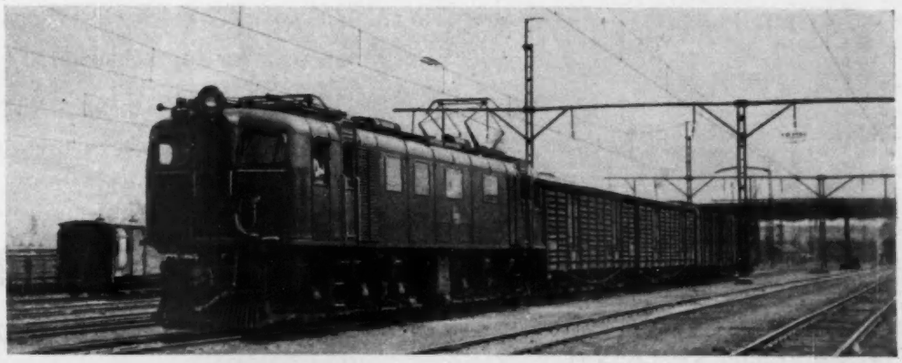
These decisions will affect many thousands employed by the two companies, though they will not necessarily apply to workers whose guaranteed week of four days is based on agreements drawn up in different terms. For example, they will not apply to the existing agreement between the Confederation of Shipbuilding and Engineering Unions and the Allied Employers' National Federation, since both Standard Motors and Lockheed are not federated firms.

There is a move afoot, however, to revise the agreement in order to incorporate the four-day guarantee. If the negotiations now in progress are successful it could mean that every worker on short time is entitled to unemployment benefit for Friday and Saturday (the benefit is not payable for an isolated day), which will amount to 13*s.* 4*d.* per employee. A ruling universally applicable could therefore have a most important bearing on the unions' attitude to short time.



Safety in Numbers

In electric traction there is experience in numbers and safety in experience. Over 400 main line electric locomotives, 2,300 coaches, hundreds of shunting locomotives, and thousands of traction motors, gear and control equipments have been built by Metrovick and are operating satisfactorily throughout the world. Few manufacturers can provide the breadth of design and manufacturing experience possessed by the Metrovick organisation. Complete rail electrification schemes including sub-stations, locomotives, automatic signalling and train lighting, workshop drives and welding equipment, lamps and fittings—all are on call from Metropolitan-Vickers.



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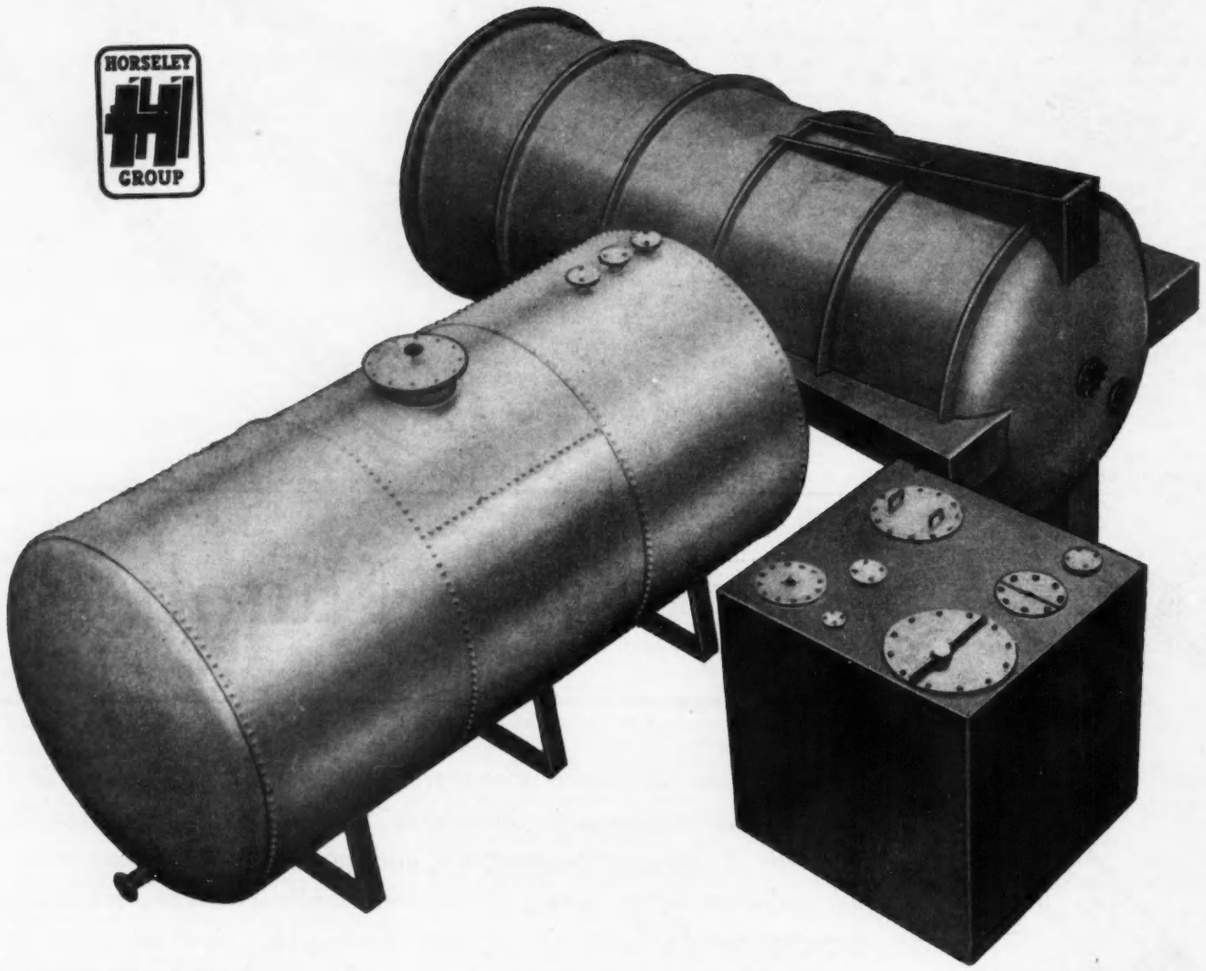

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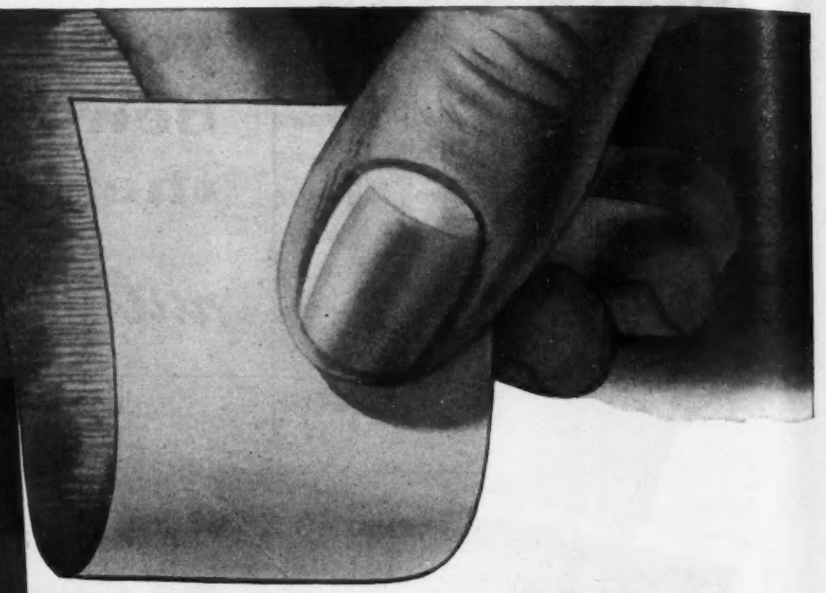

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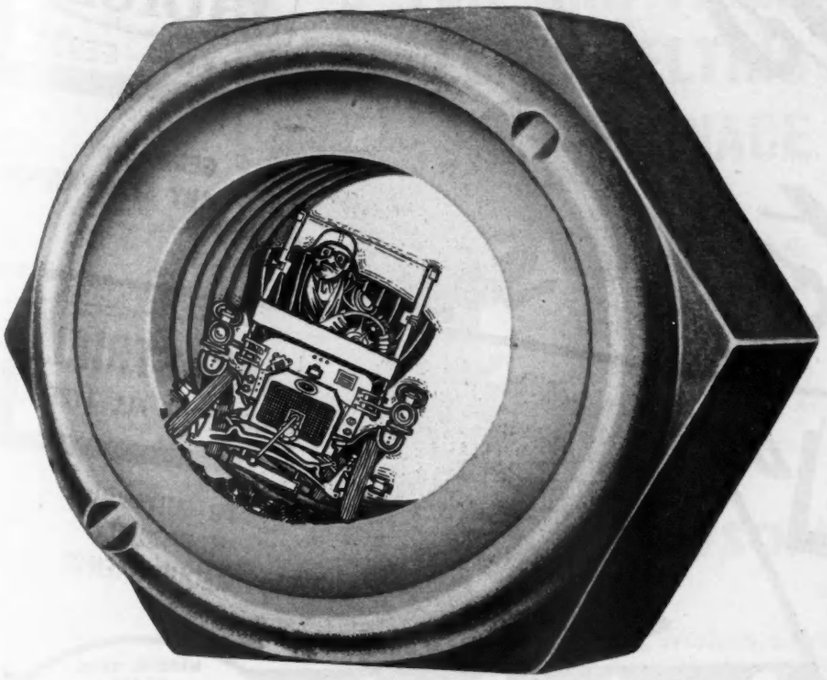
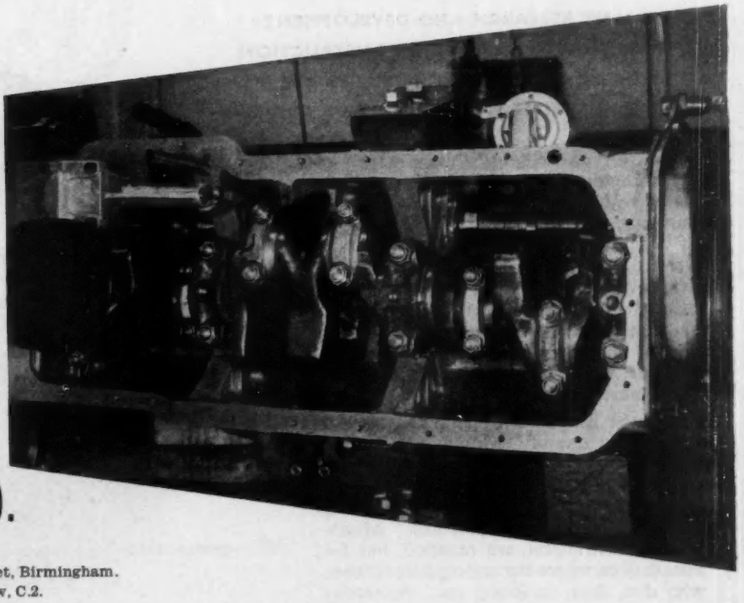


. . . but nothing rattles the NYLOC



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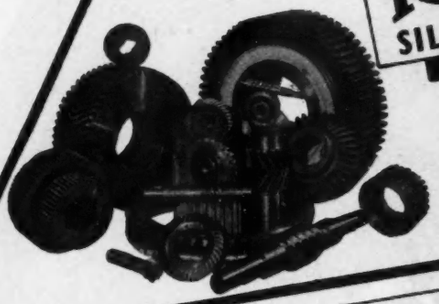

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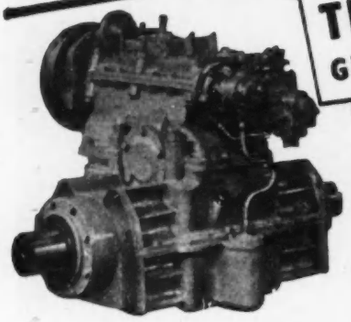

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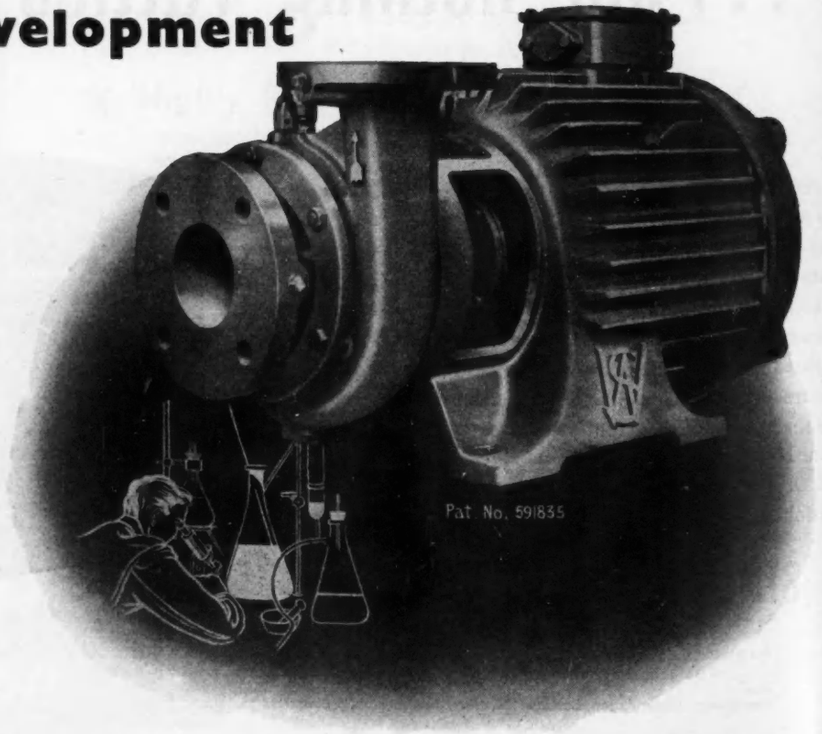

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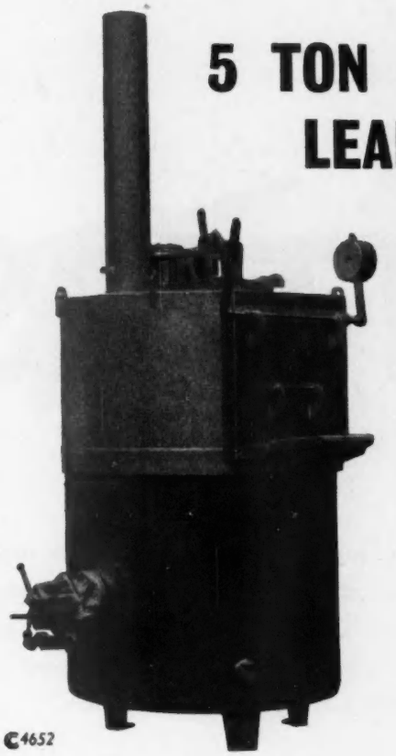

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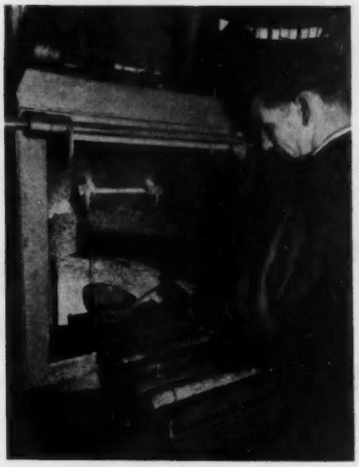

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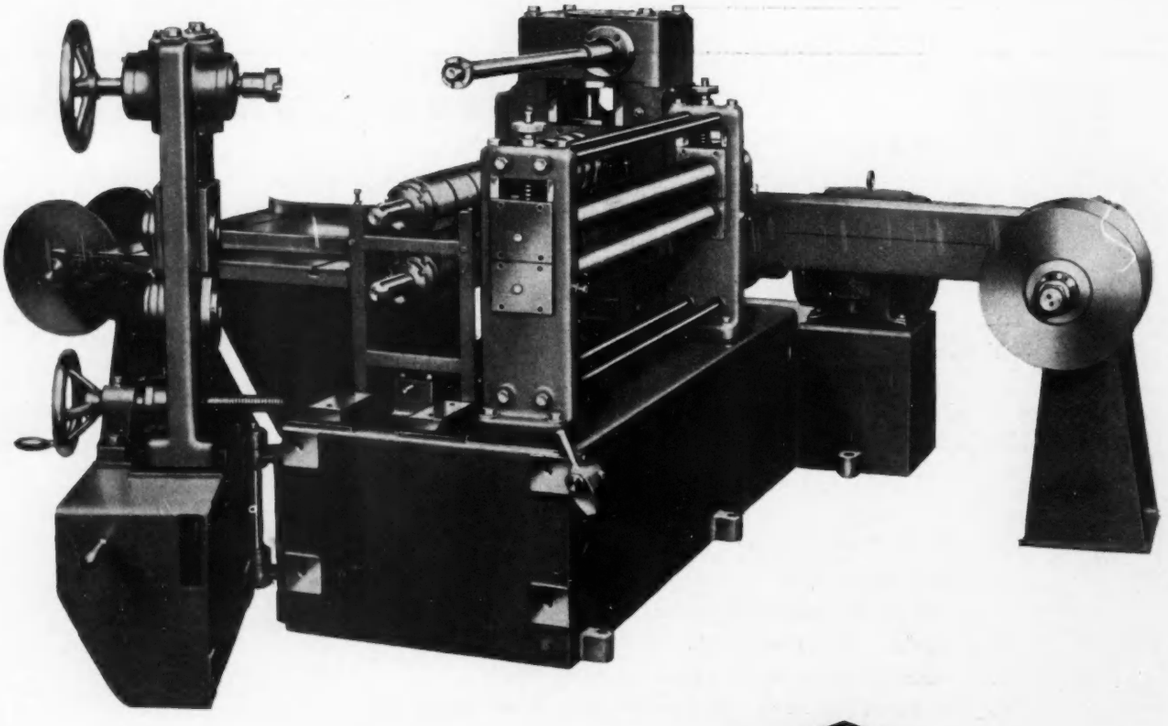

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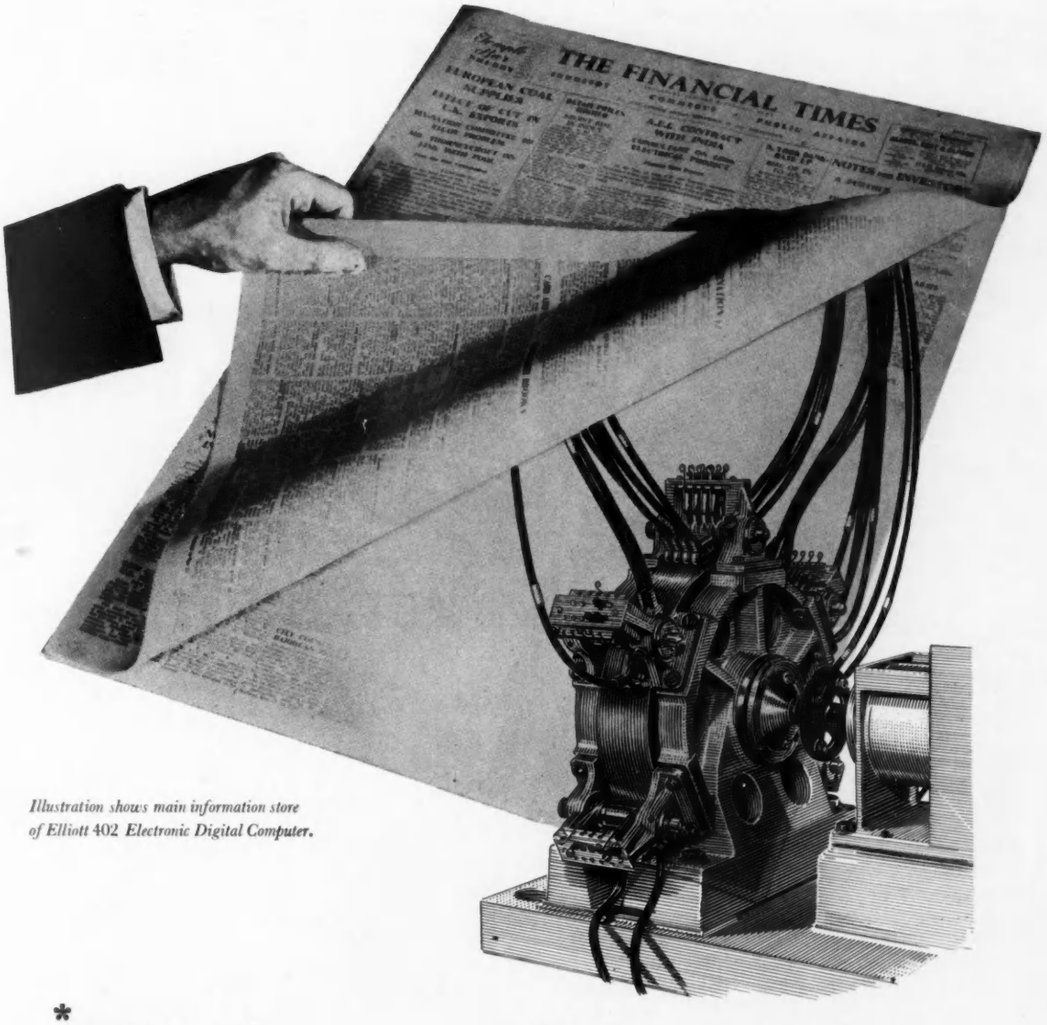

Illustration shows main information store of Elliott 402 Electronic Digital Computer.

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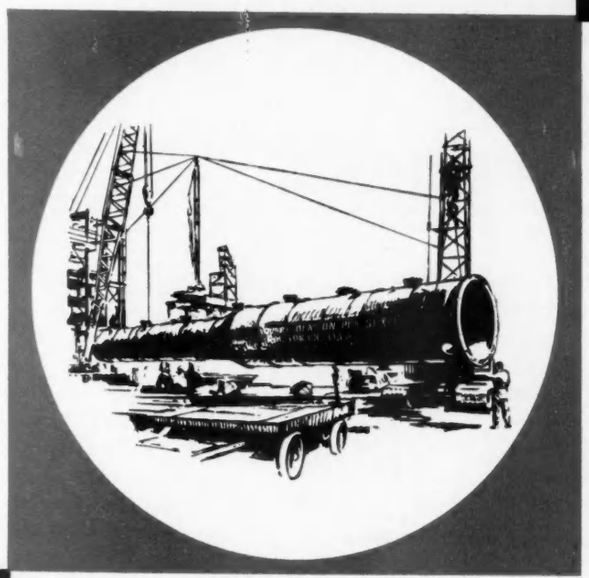

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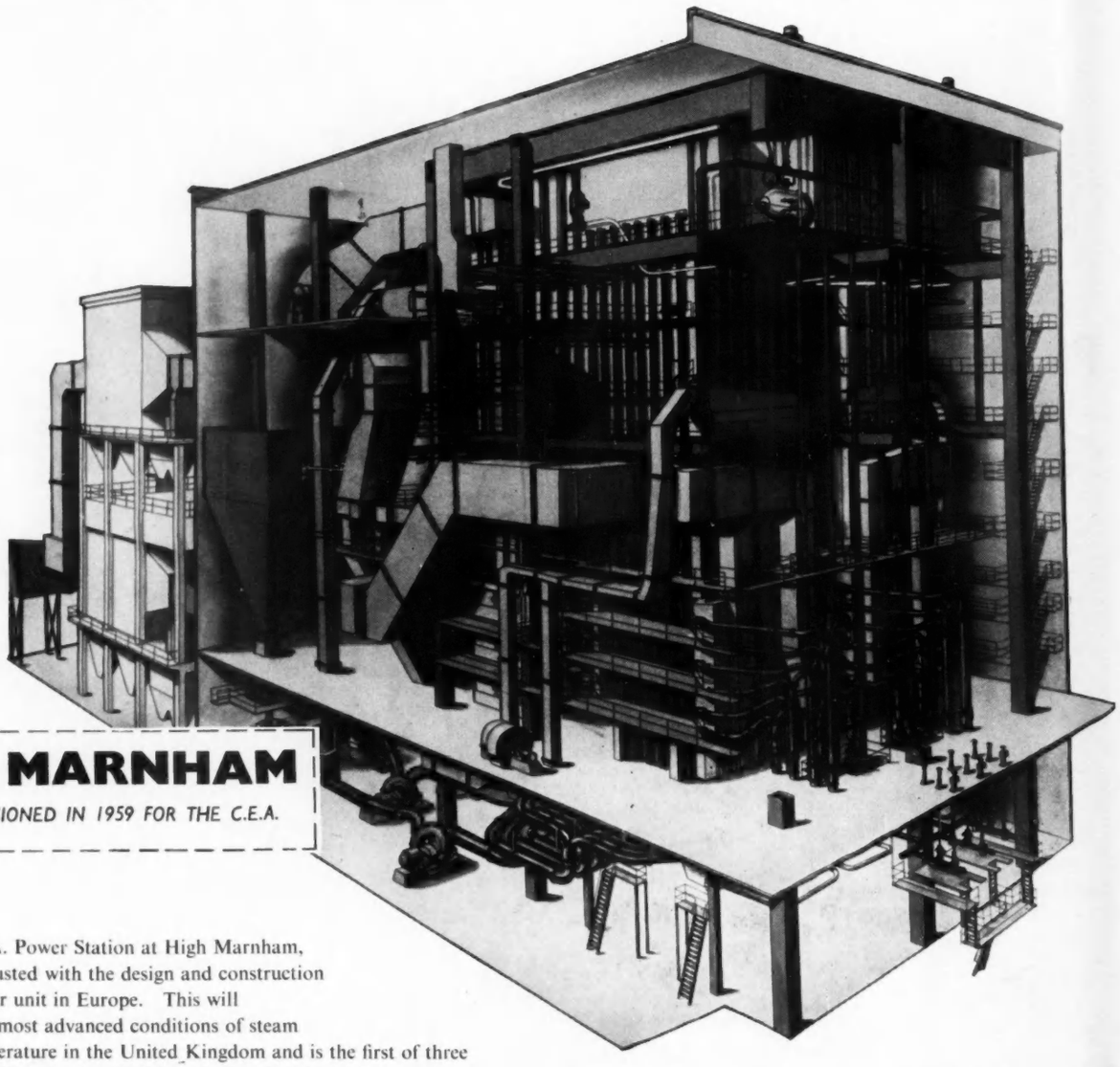
FACTS about the largest boiler plant in Europe . . .



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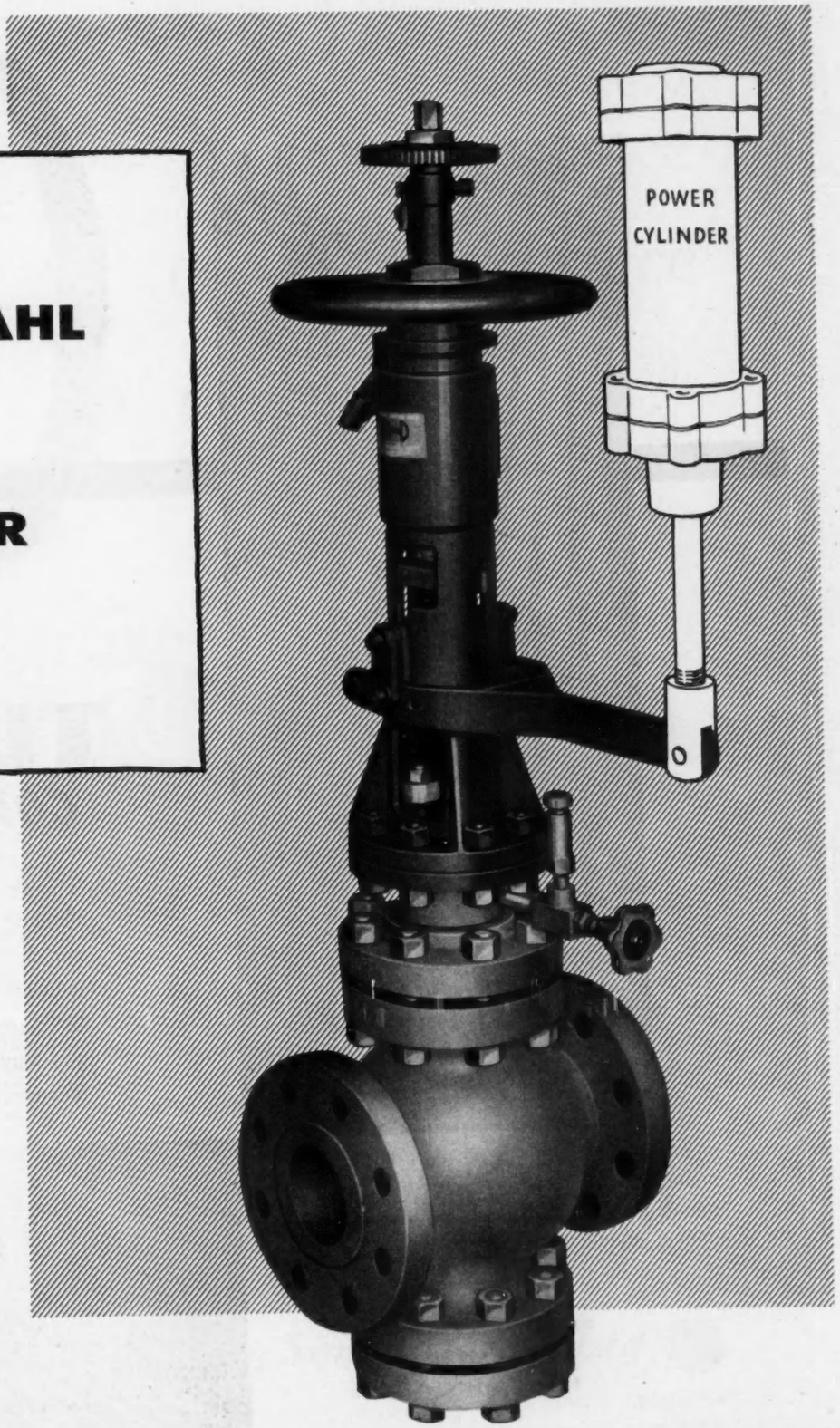

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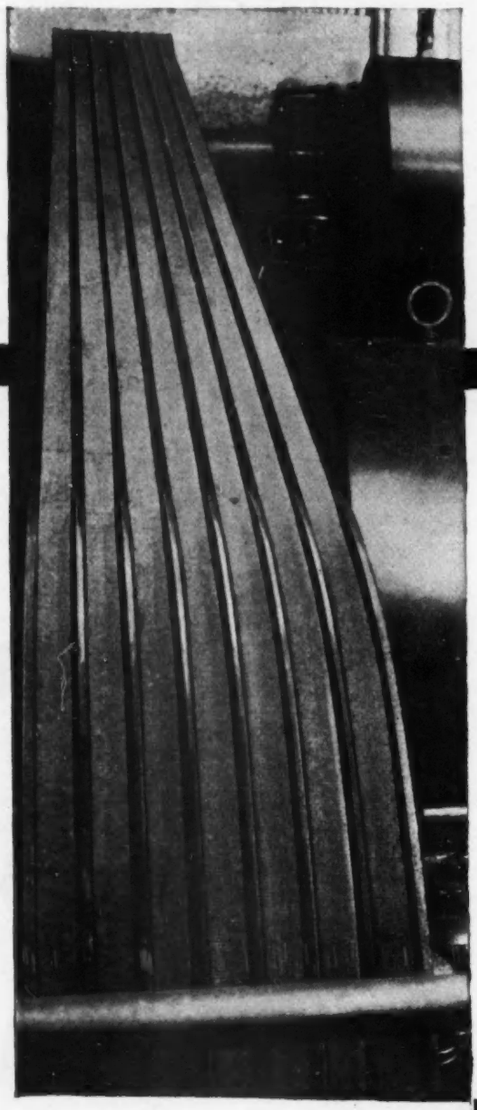

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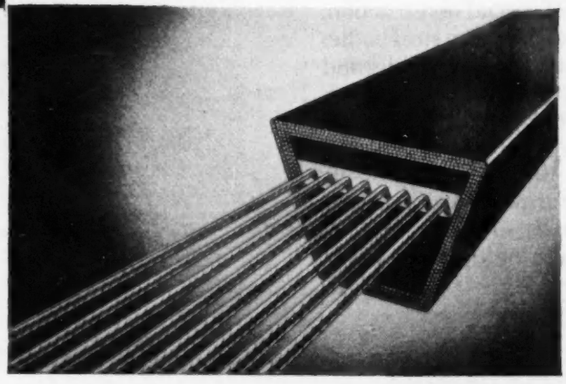

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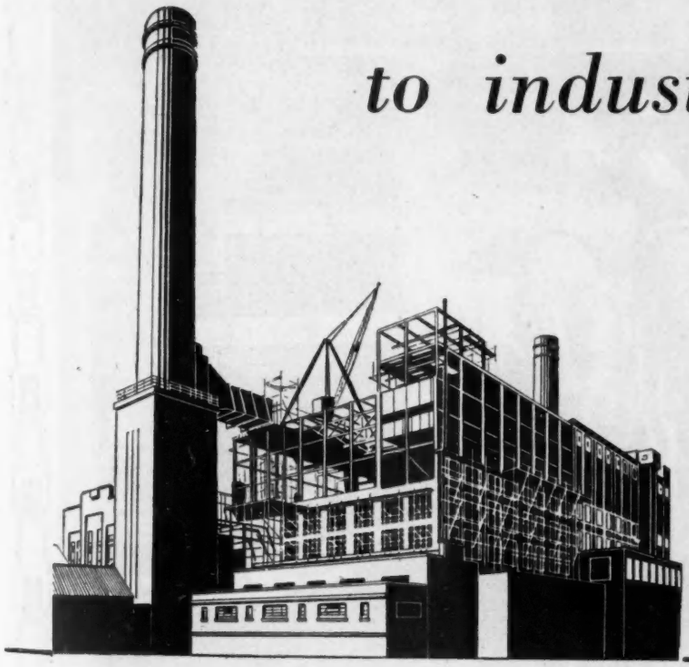

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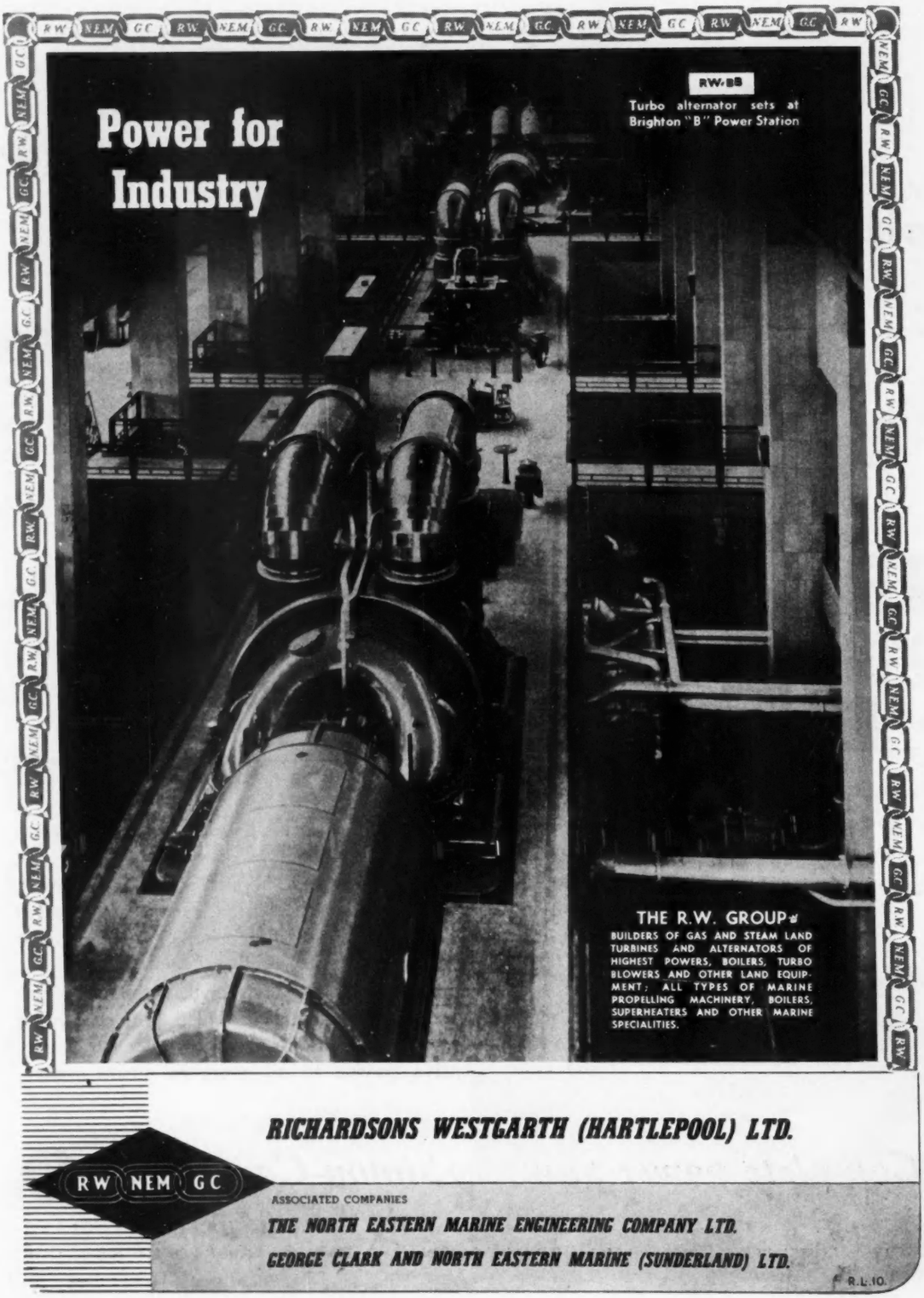
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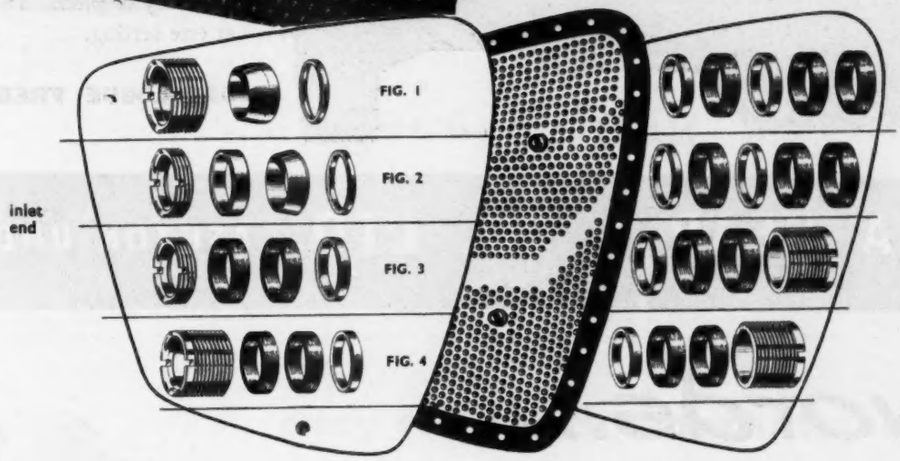

This composite illustration is designed to show the arrangements at the inlet and discharge ends of condenser and heat exchanger tubes, when any one of the four main assemblies comprising the Crane condenser process is used. These combinations cover the requirements of most installations, but there are alternatives which may be used in special circumstances. The Crane process eliminates altogether damage resulting from deformation of the tube ends, it reduces considerably the extent to which a tube is subject to erosion or abrasion and because of the bond which is formed between the tube plate and the tube, electrolytic action cannot take place.

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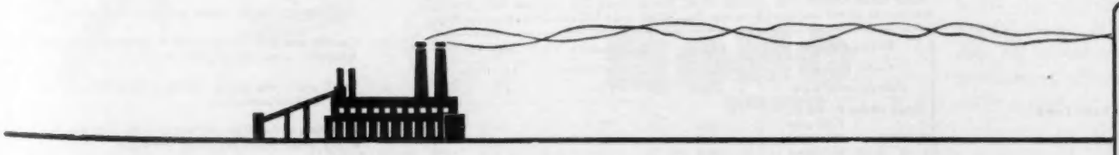

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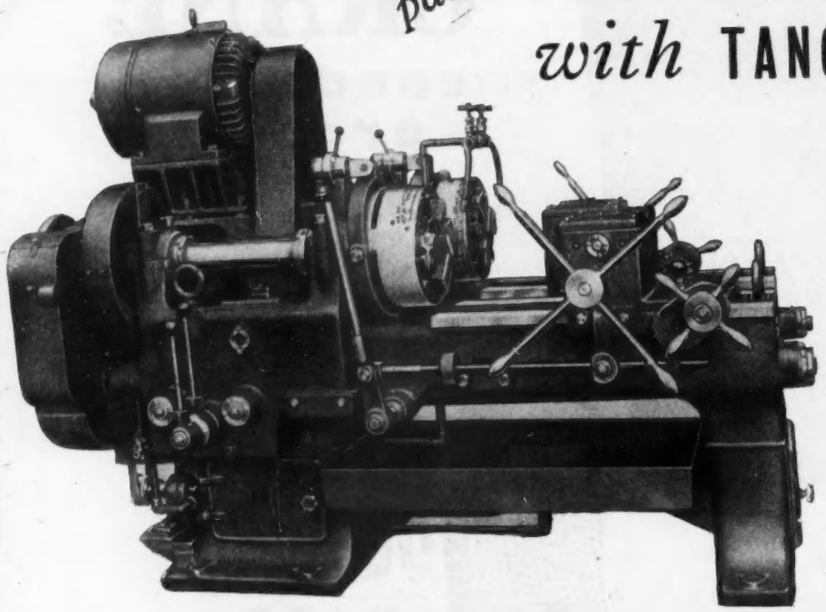

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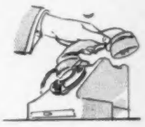

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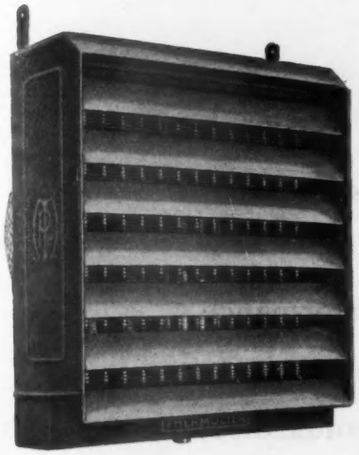

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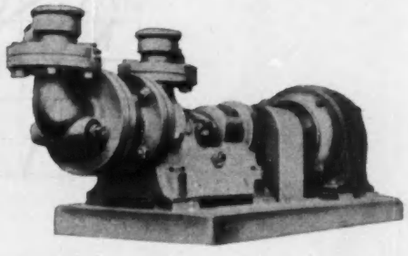

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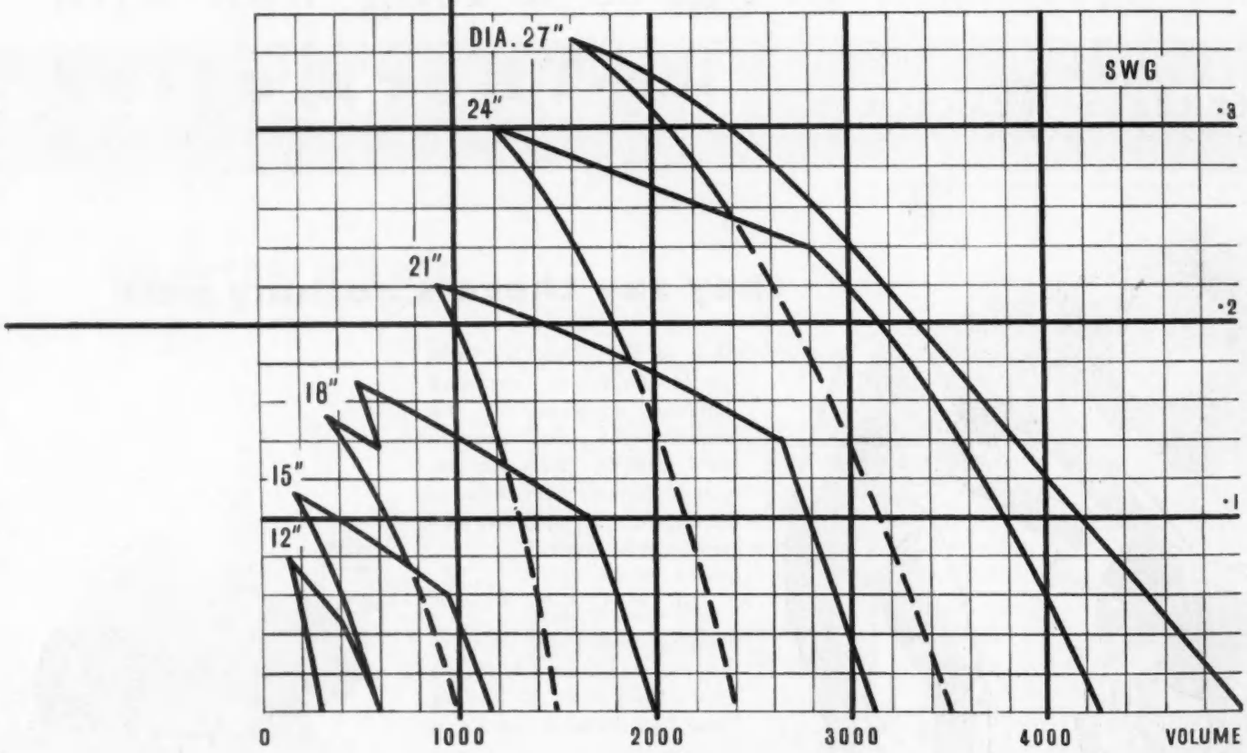

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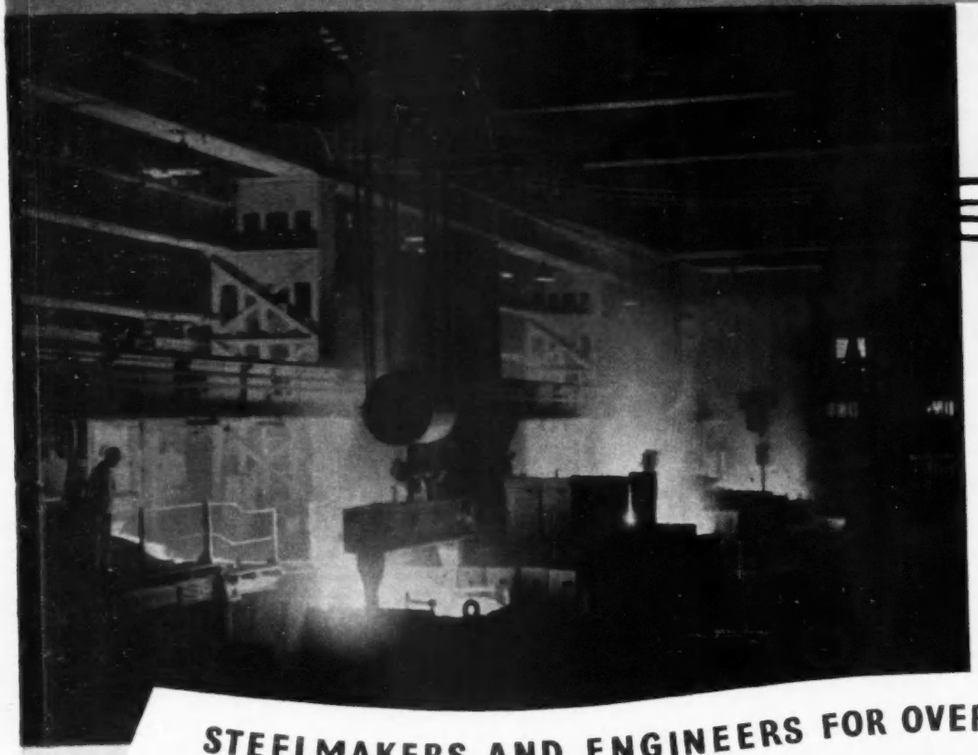

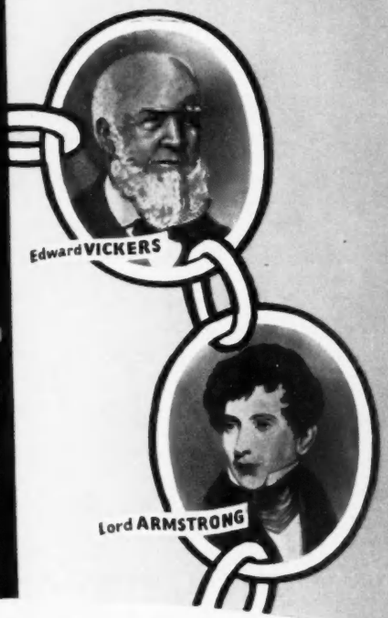

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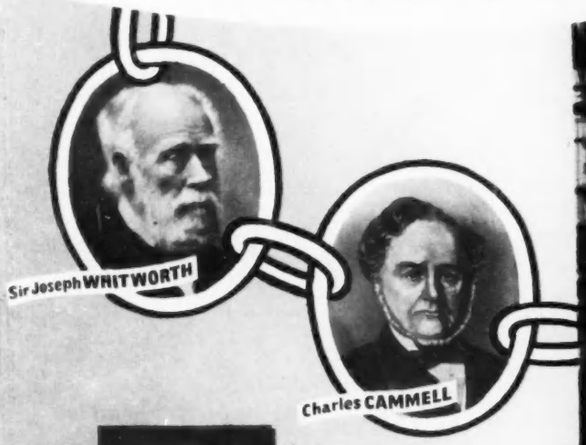

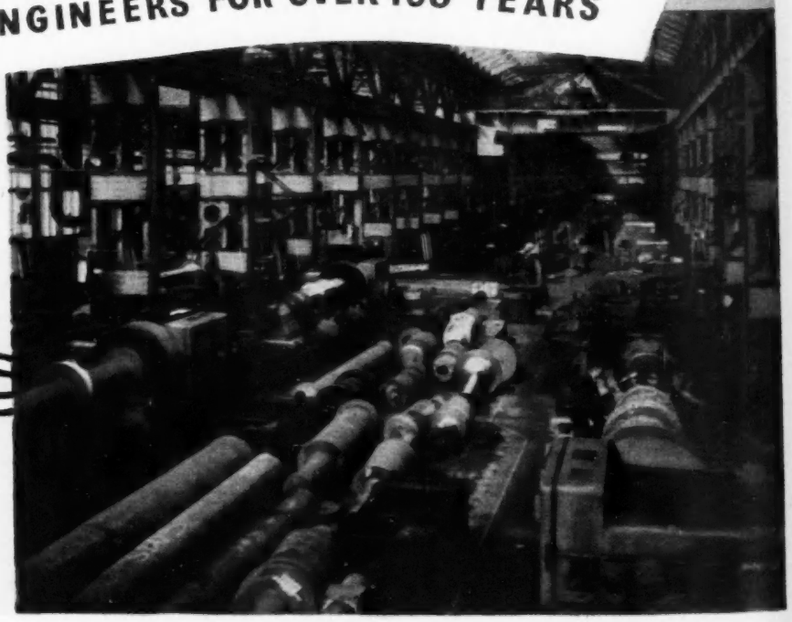

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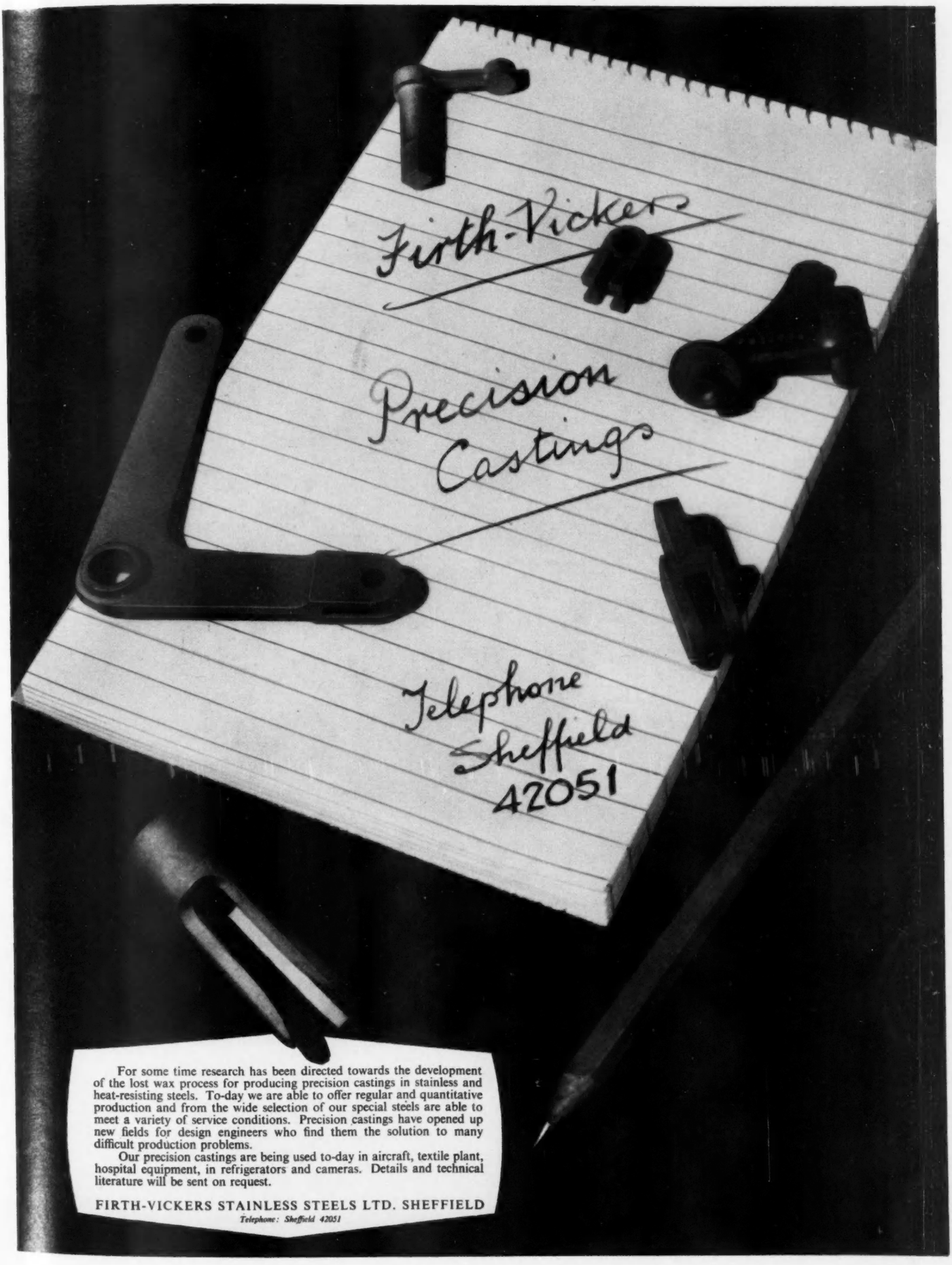

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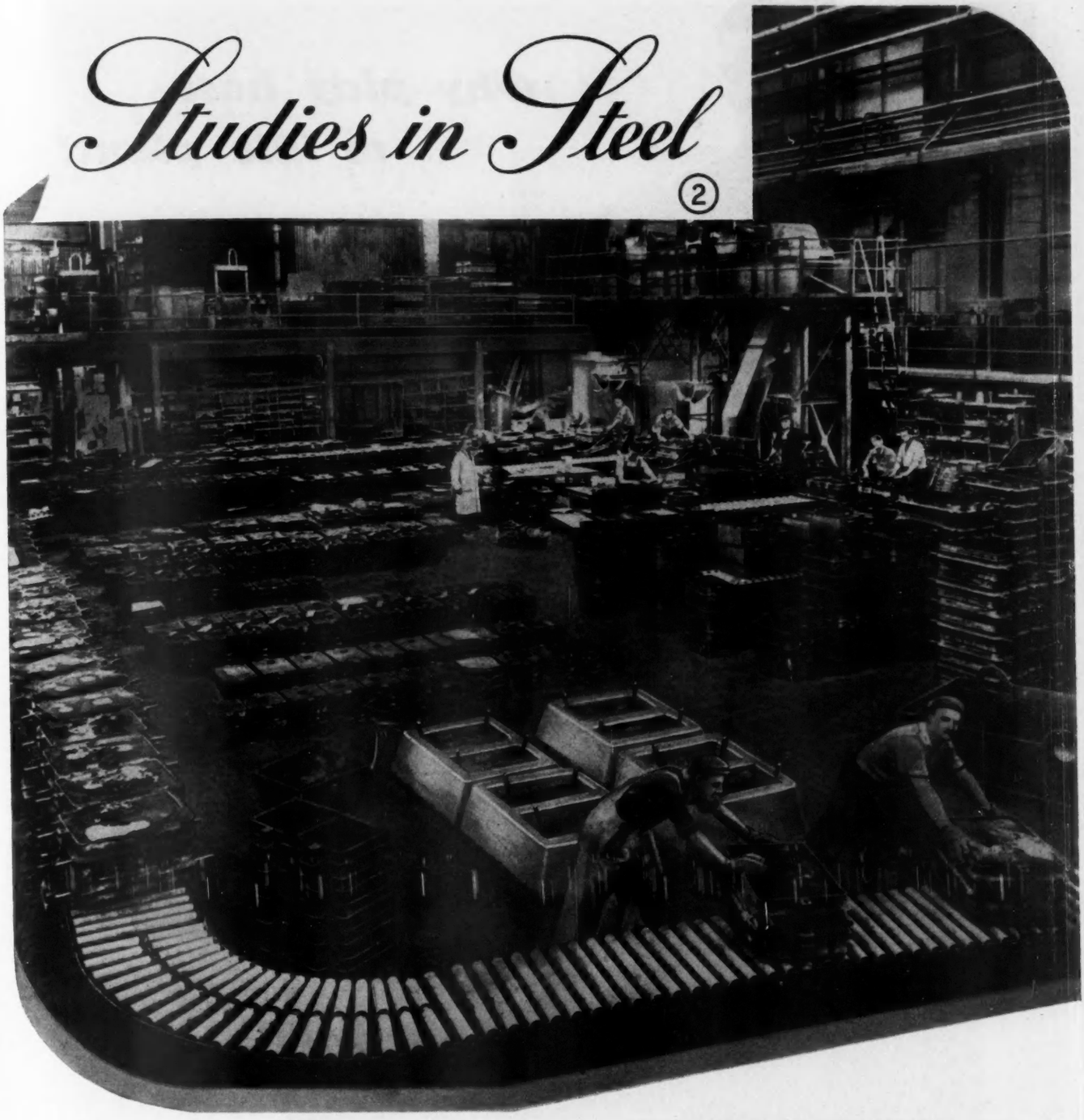

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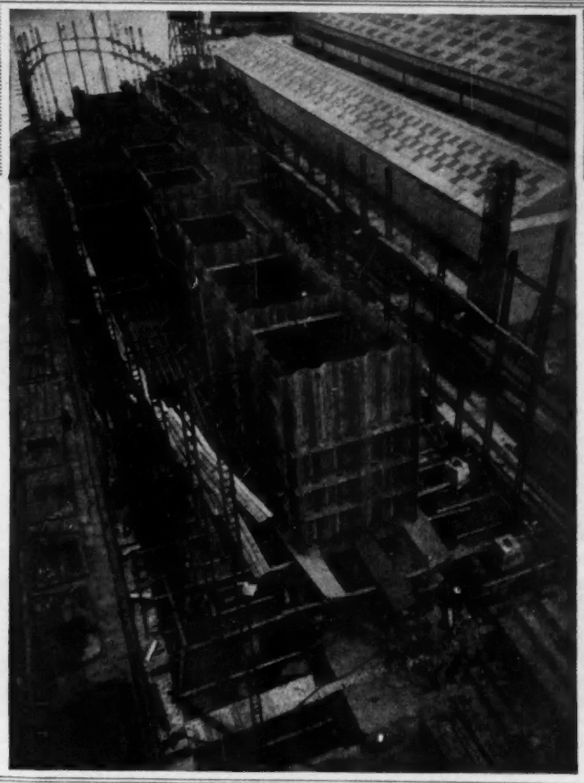
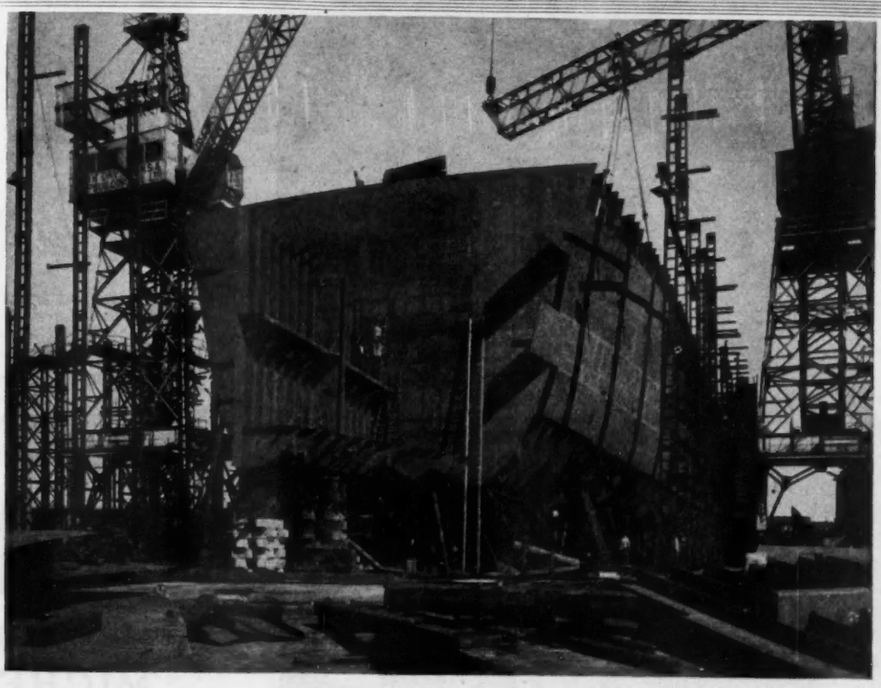


Right : Showing the centre cargo tanks erected ; both the transverse and longitudinal bulkheads are of corrugated plates troughed at the shipyard.

Right : Main bulkheads of corrugated plates and transverse side frames of 10" × 0·45 bulb flats. Note the fabricated deck panel in the foreground.



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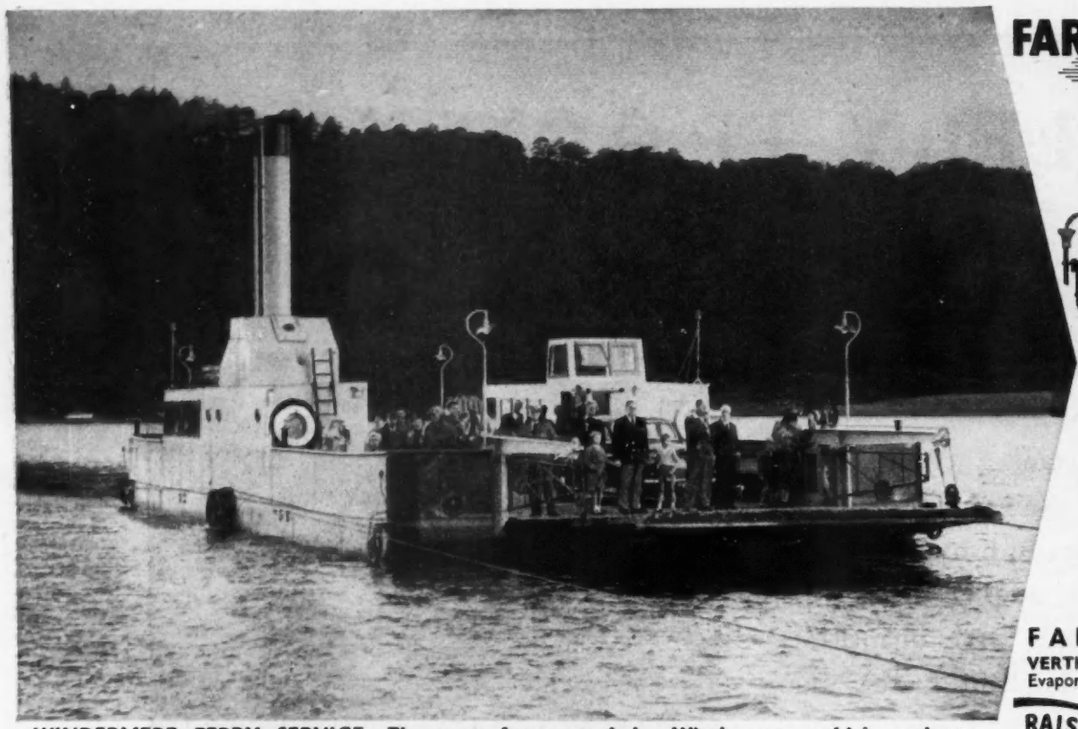

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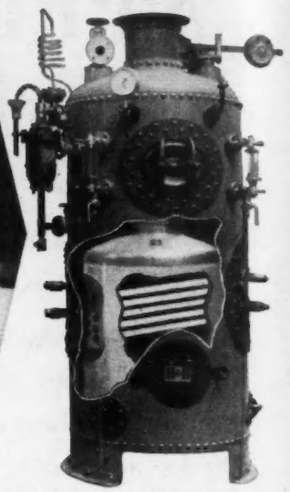

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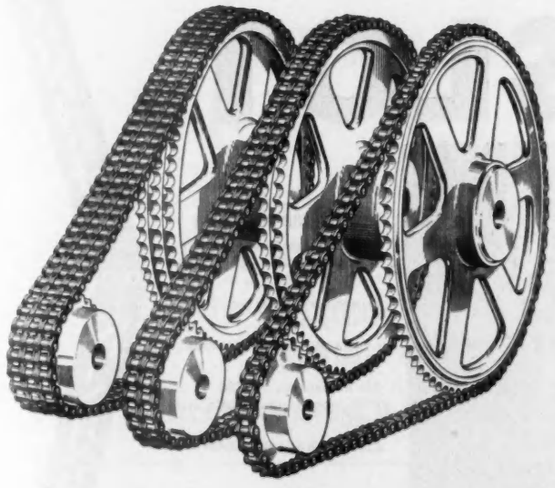

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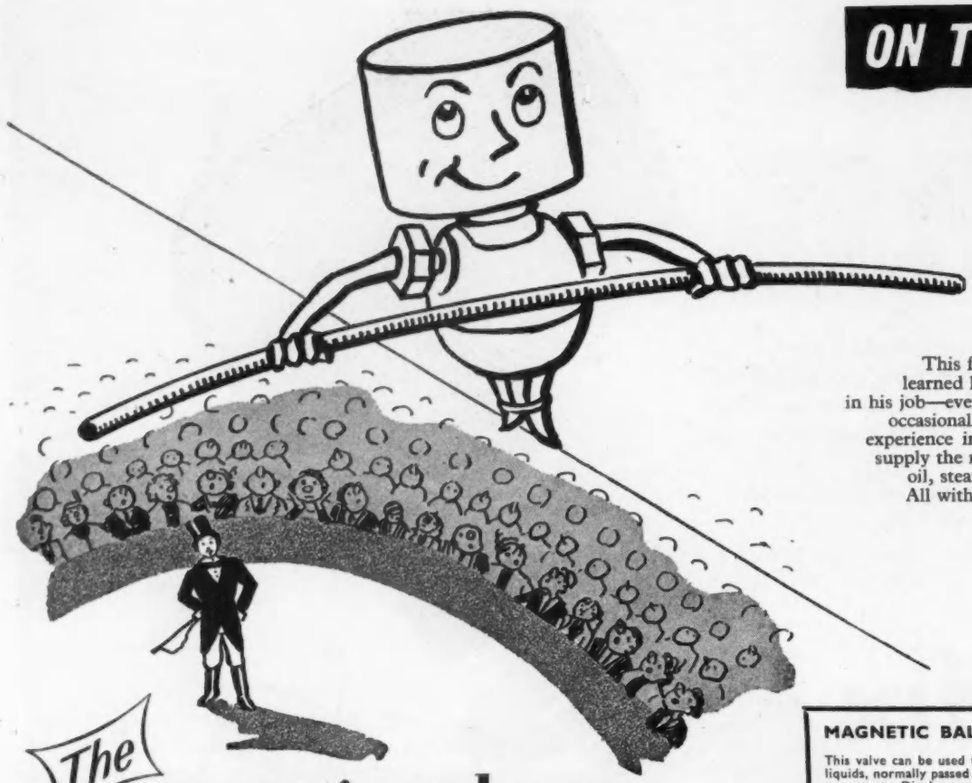

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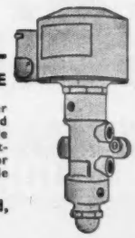

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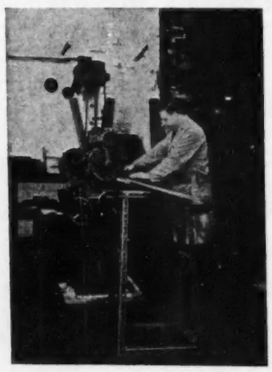

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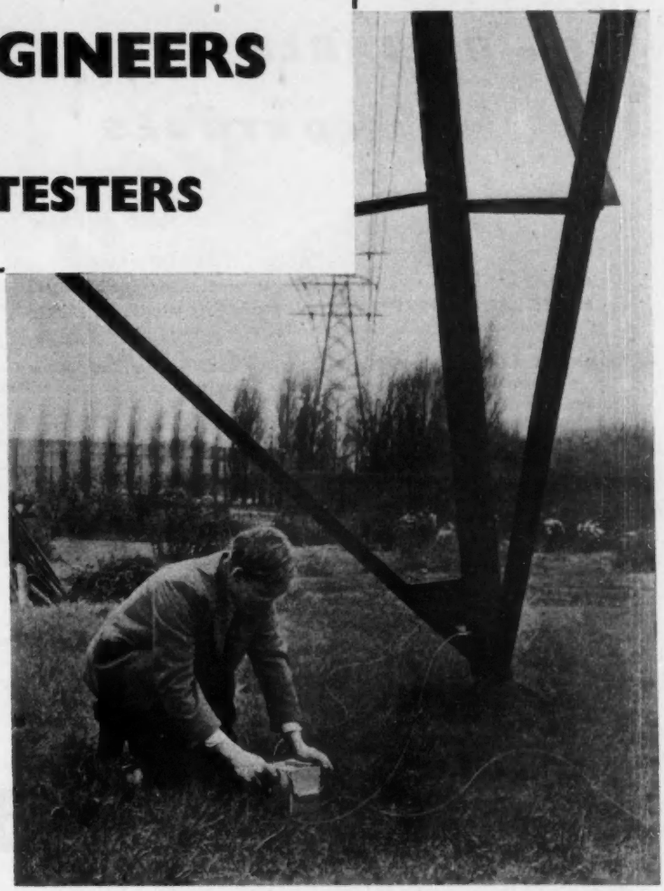

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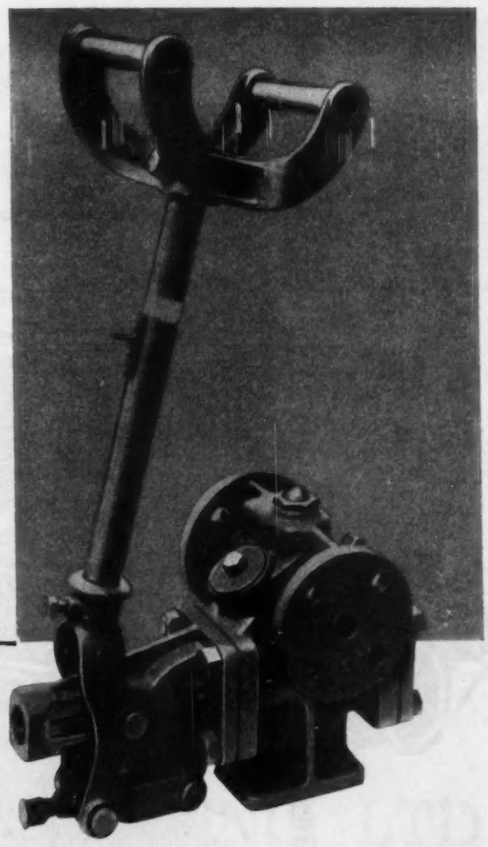

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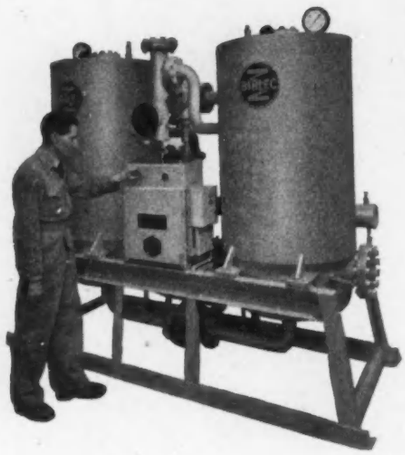

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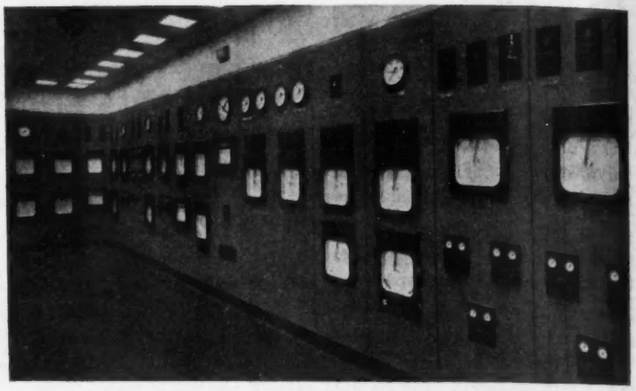

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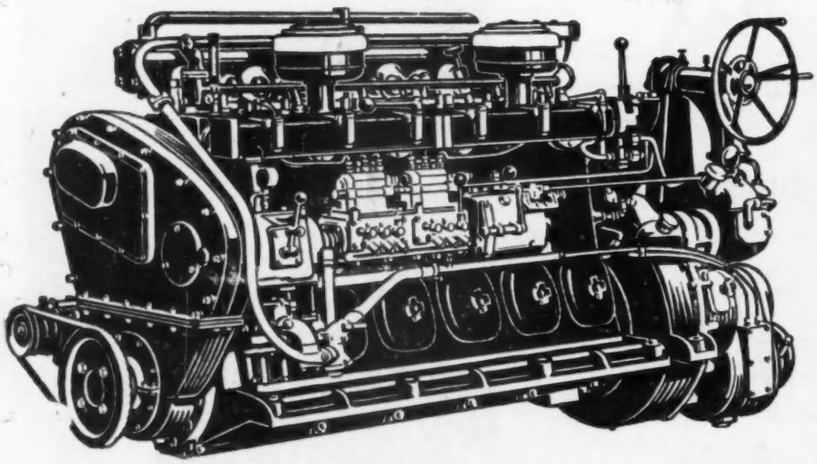

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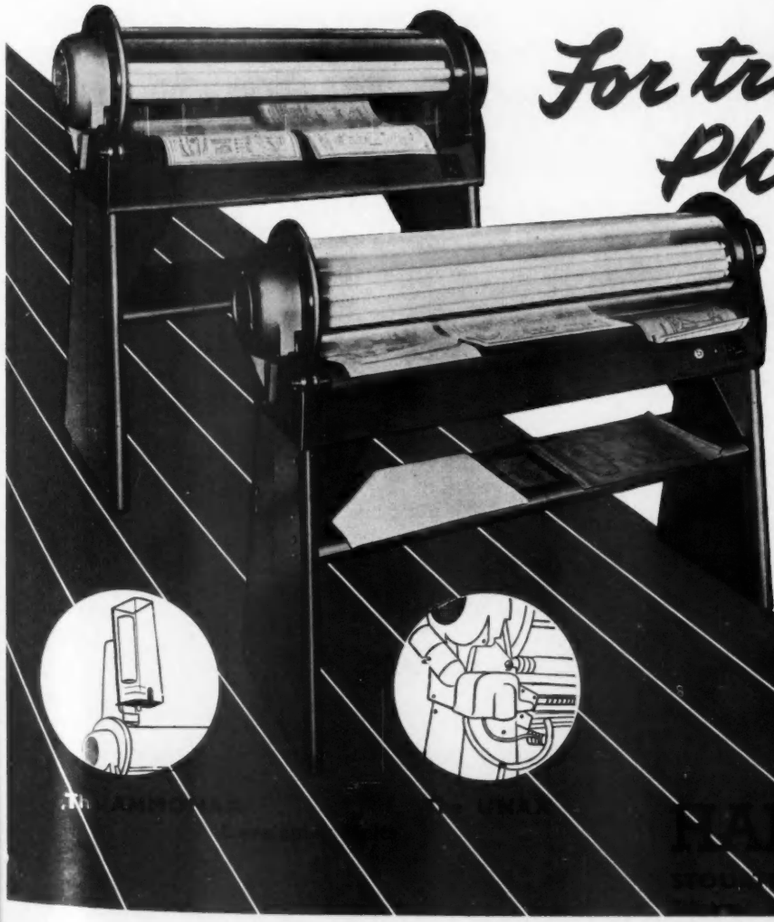

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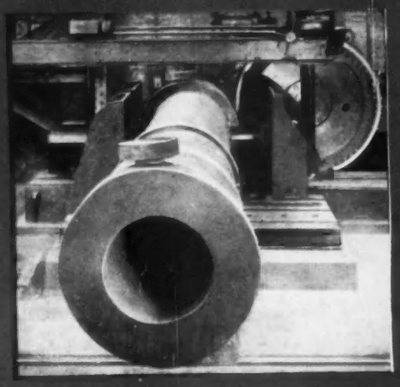
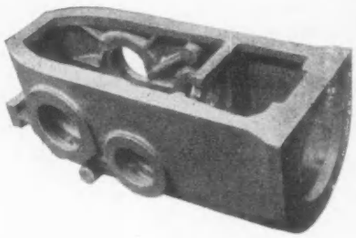
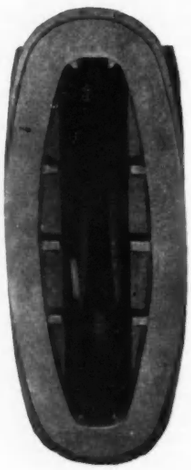
SPORTING & FOUNDRY LIFE

(huntin', shootin', castin')



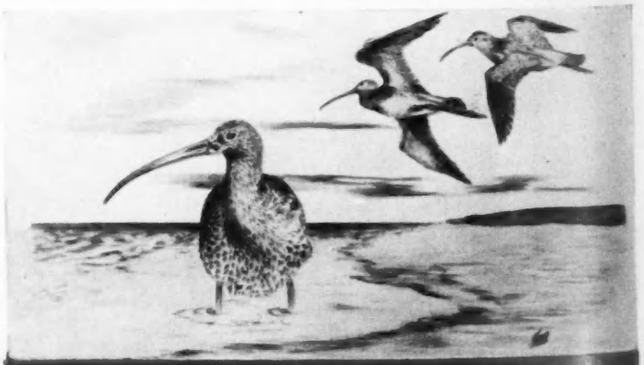


We are looking up the spout of a worthy piece of sporting artillery (above) which we once cast when our everyday fowling pieces were in dock because of powder fouling. The reason we tried using cannon was that if we were to have missed a phestoon of pheasants, or a pride of partridges when the cannon balls went up, we might have got a score of duck or a surfeit of lampreys when the balls came down. Actually, we never even sniped a snipe with it, and quails quailed at the sight of it. On one of our rotary planers we machined the ends as flush as our rich uncle.



The designer of the gearbox (above) said "Let 'em lubricate the gears with water; let 'em knock the gear lever in with a 28 lb. hammer; let 'em grind the gears like a barrel organ; this box is going to take it". We cast it in our foundry. It took it. Here are some castings (left) which we produced in moments of self-expression. Much thought and feeling went into their creation. They sold readily, and a customer telephoned to tell us that we had plenty of clues; it might have been curlews; we couldn't quite hear what he said for the sound of gunfire outside the offices.

CASTINGS IN WEST COAST HEMATITE IRON



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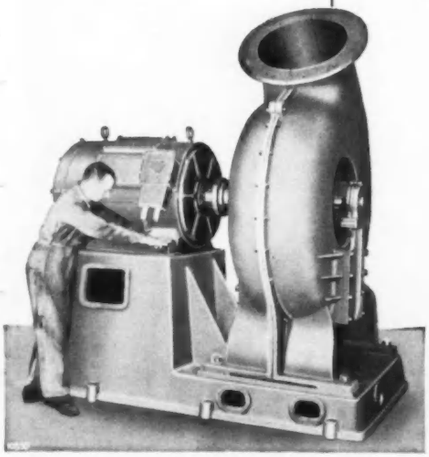
Sturtevant supply fans of all types, sizes and capacities, and have unrivalled experience in meeting the requirements of every kind of industrial application —from a single fan to complete installations providing the appropriate forms of air control and movement.

Long term running costs are always taken into consideration, as fans usually have to run continuously—frequently 24 hours a day. The correct selection and the high efficiency of Sturtevant Fans avoid waste of power, thus producing substantial savings over the years. An example of this is the centrifugal fan with aerofoil section blades **operating at static efficiencies up to 84 per cent.**

The top illustration shows a 40in. diameter Sturtevant Adjustable Pitch Axial Flow Fan for ventilation air supply to oil refinery can filling building in the Persian Gulf. It is driven by an 8½ h.p. flameproof motor of approved design at 1,450 r.p.m. to deliver 22,500 c.f.m. against a static pressure of 1in. w.g.

The illustration on the left is a Sturtevant double inlet 'Monogram' fan direct coupled to electric motor by a flexible coupling. The output of this fan is 15,000 c.f.m. of air at 26in. w.g. Many thousands of these fans are in service in all parts of the world—a very full range is made for diverse applications.



Sturtevant engineers are ready to investigate potential applications and submit their recommendations. Please write to our reference D/101/FGL.

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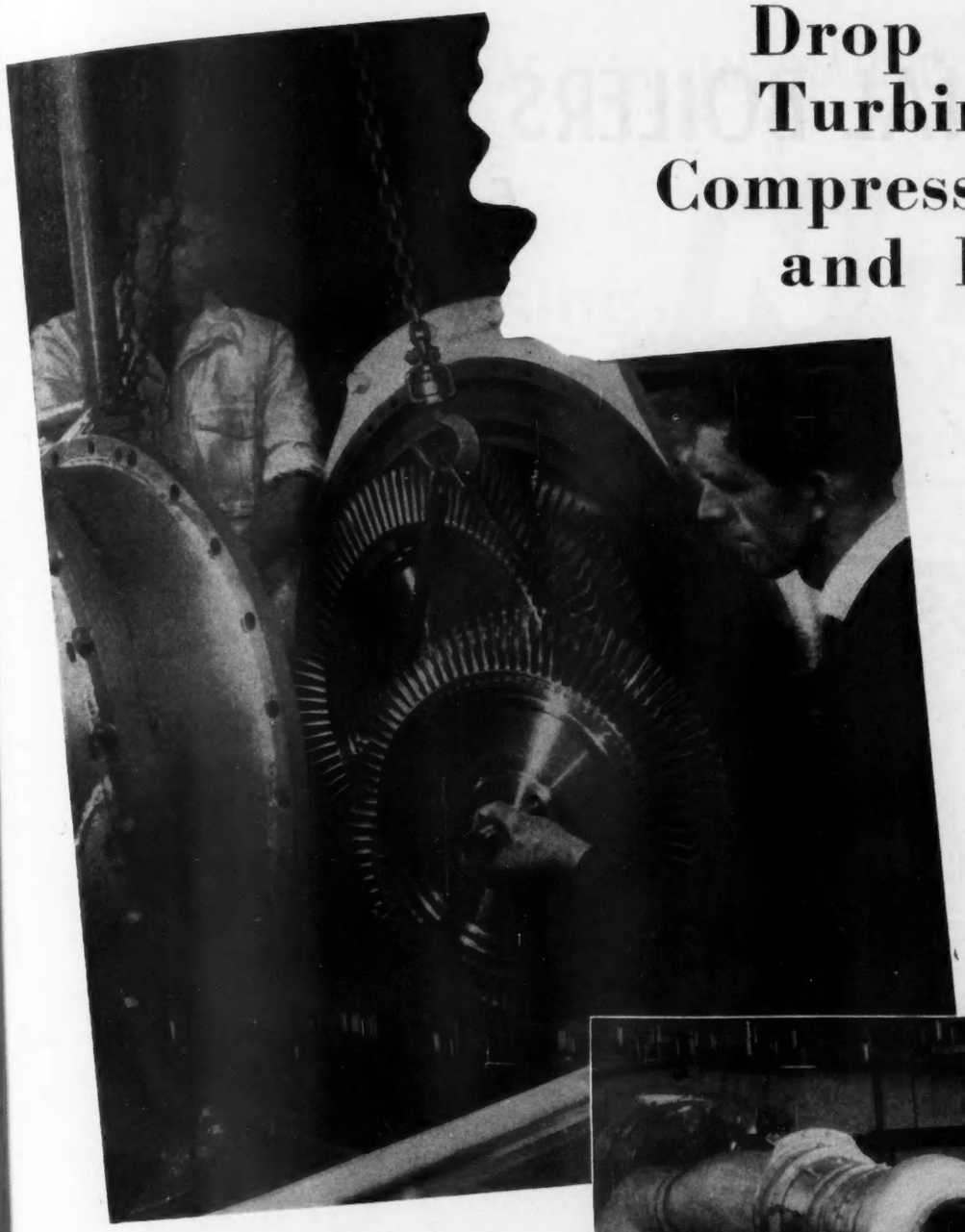
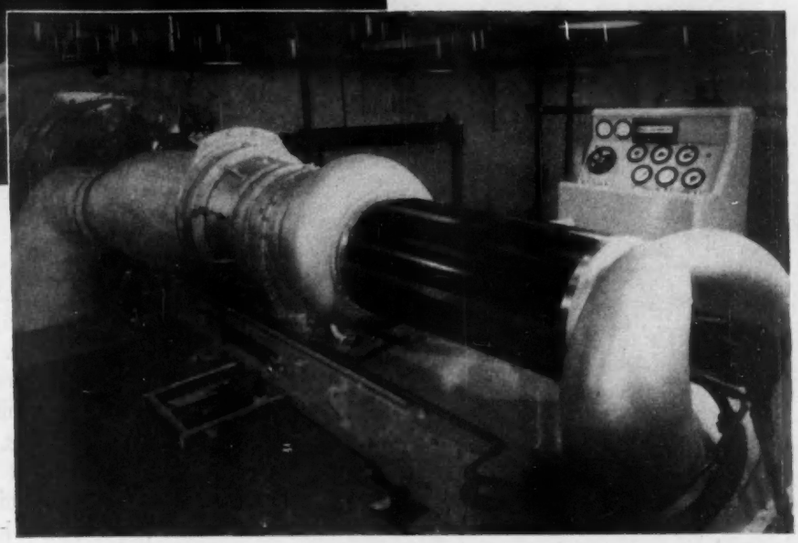
Drop Forged Turbine and Compressor Discs and Blades



Firth-Derihon Drop Forged Turbine Discs in F.V. 448 Steel being fitted in a 900 kW Gas Turbine Generator Set.



900 kW Gas Turbine Generator Set.

(By permission of Messrs. Ruston & Hornsby Limited, Lincoln.)

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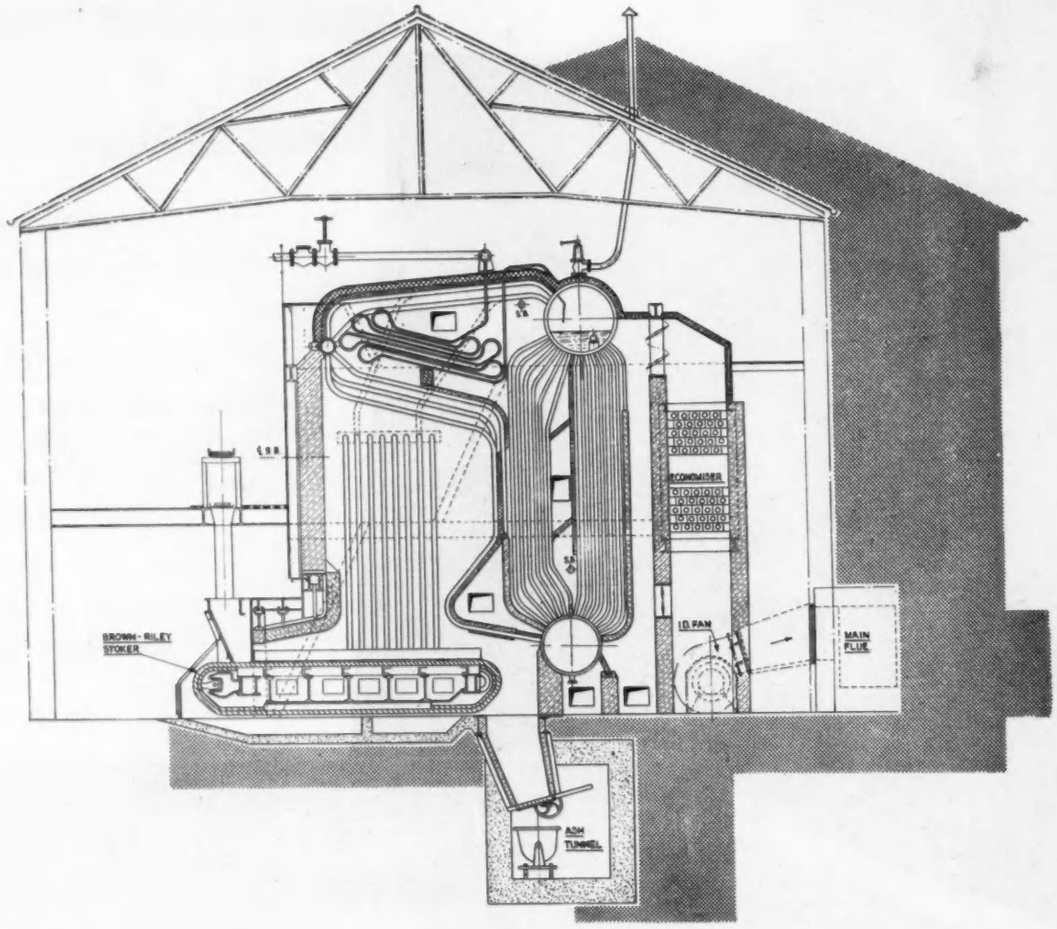

At Whitecrook Works, Clydebank, we build Industrial Boilers ranging in capacity from 14,000 lb./hr. to 150,000 lb./hr. Complete ranges of Mechanical Stoker or pulverised fuel firing equipment and all auxiliaries such as Economisers, Airheaters and Mechanical Draught Plants are supplied to suit individual requirements.

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WHITECROOK CLYDEBANK GLASGOW

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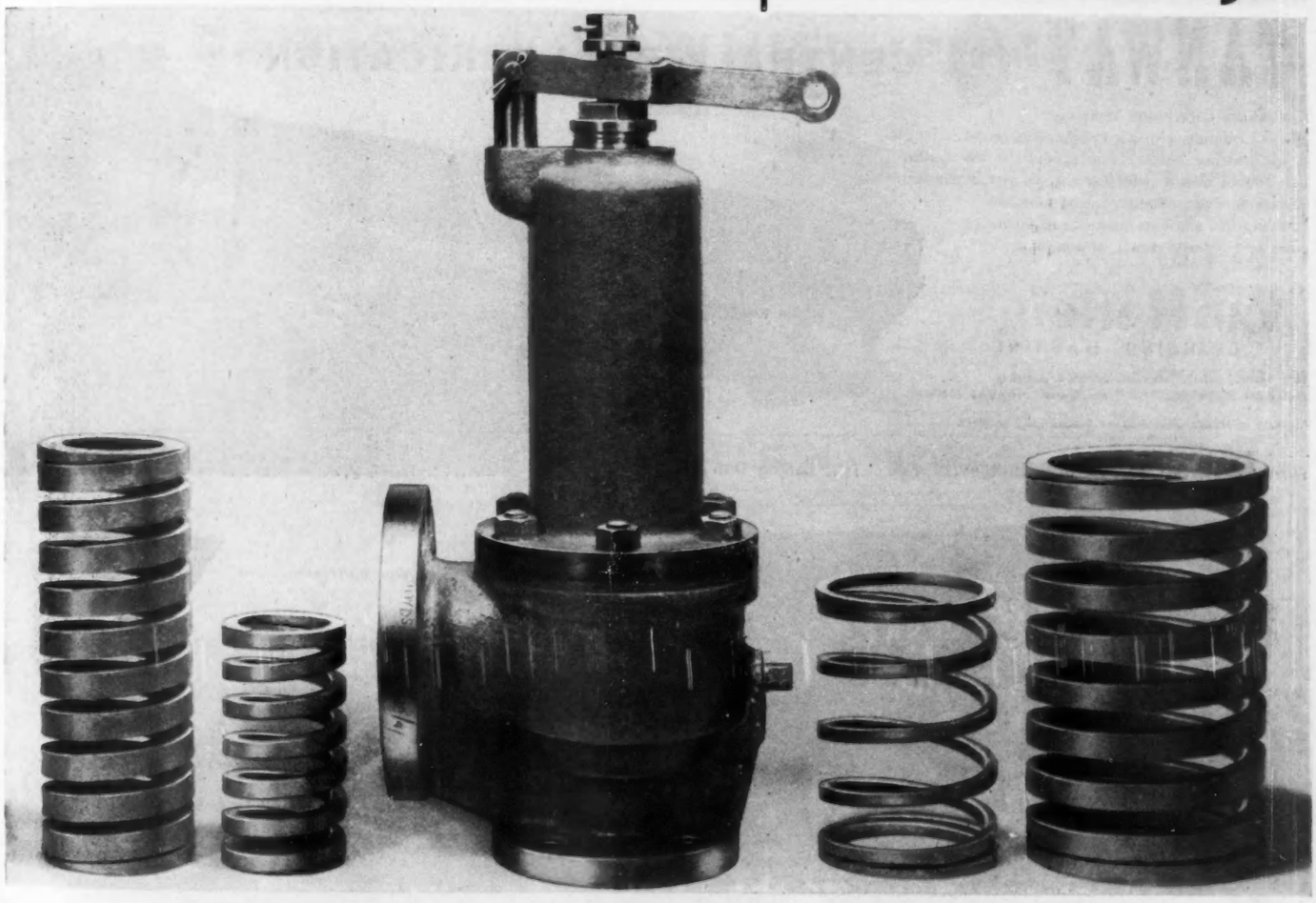
Now they're using NIMONIC alloys



Cockburns Ltd. of Cardonald, Glasgow, with almost a century's experience of safety valve development behind them, manufacture a safety valve termed the Improved Full-lift Nozzle Type. In this valve the exhaust gas pressure — usually detrimental to the lift in ordinary valves—actually assists the lift by acting on the piston operating through a loose ring, which is held down by the pressure. The valve has no wings to jam. Operating at high temperatures exceeding 400°C and in the severe conditions of chemical processing and power-station plant, the normal spring materials proved unsatisfactory.

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This application is typical of the many ways in which the Nimonic series of heat-resisting alloys is increasing efficiency in industrial processes which involve severe temperature conditions.

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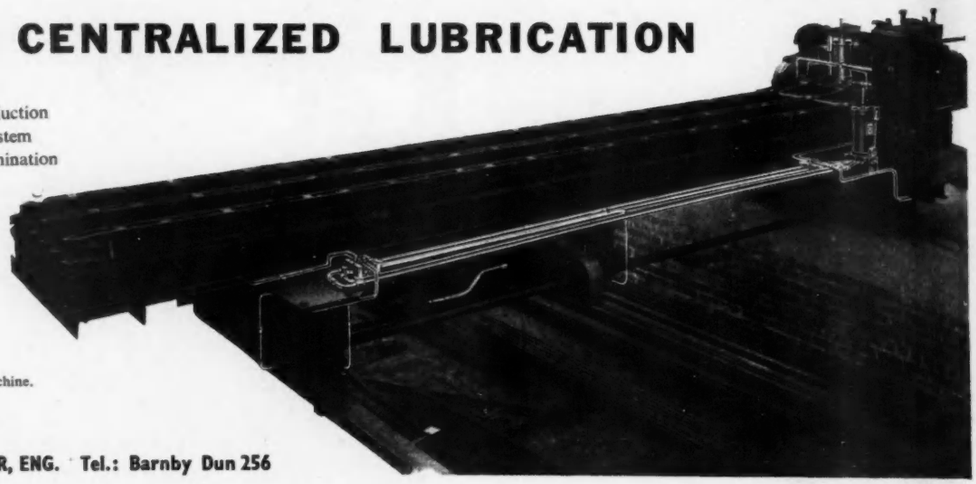

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CHARGING MACHINE

Two Tanway GP412 manually-operated pumping units feeding 24 points on a "Van Marle" Charging Machine.

Courtesy of Messrs. John Bedford & Sons Ltd., Sheffield.

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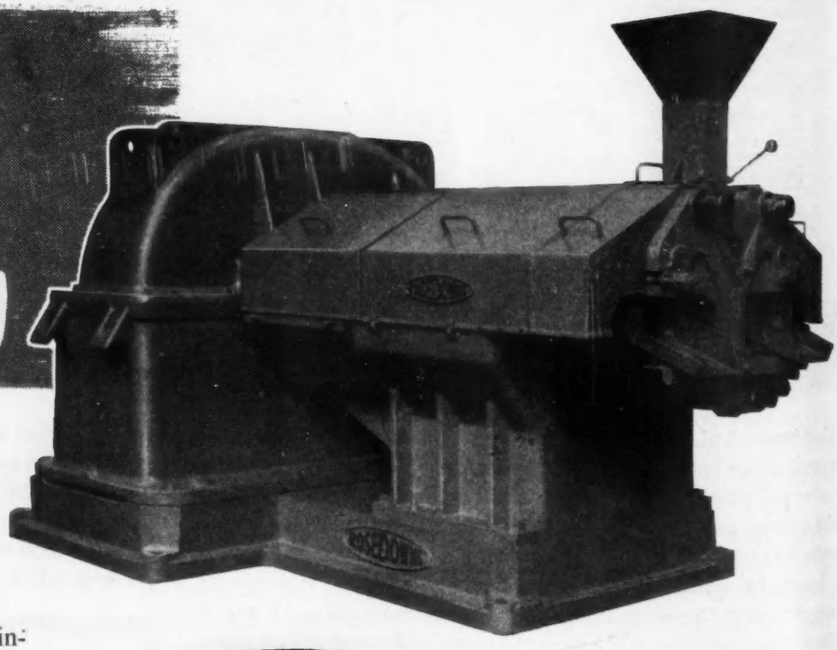

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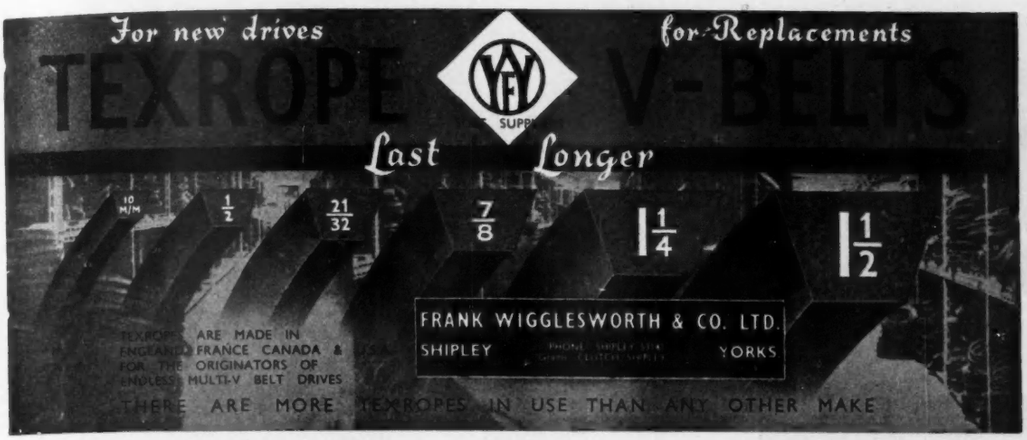

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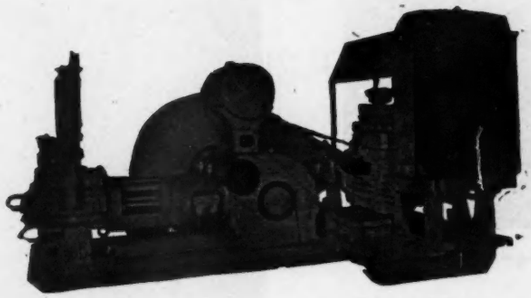

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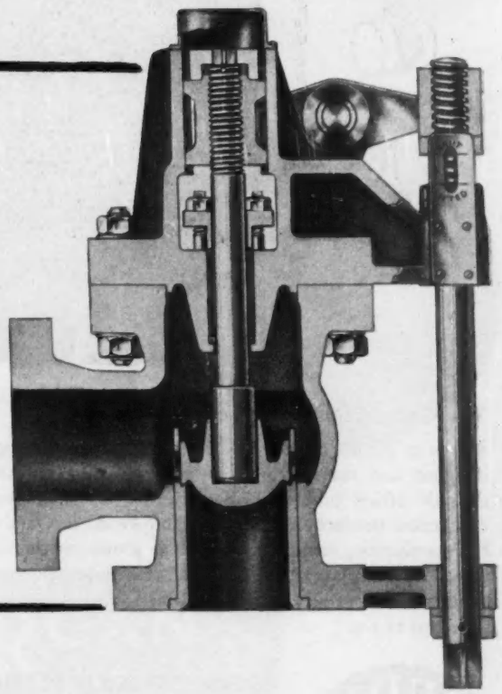

For remote operation the Rocking Lever gear (as shown) eliminates the low mechanical efficiency of the Spur type.

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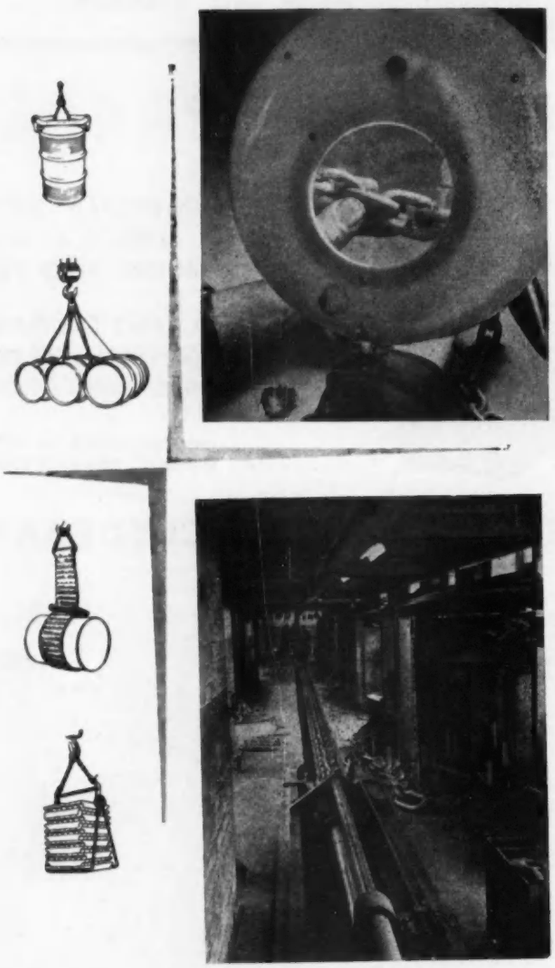

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Shown at the left are a few of the special purpose lifting attachments designed and manufactured by us; we enjoy grappling with the difficult lifting problem! Equally, we are well placed for the economical production of the straightforward job, and our facilities for examination, testing and repair, as shown on the right, are very complete, both at Manchester and Glasgow. Every job is fully certificated. Our services are available from whichever of our works is nearest to you.

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GLASGOW WORKS: *Adelphi Engineering Works, 135/143, Reid Street, Bridgeton, Glasgow, S.E. Telephone Nos.: Bridgeton 2141/2/3. After business hours: Giffnock 1900. Area Manager, Lifting Tackle Services: A. Davidson.*

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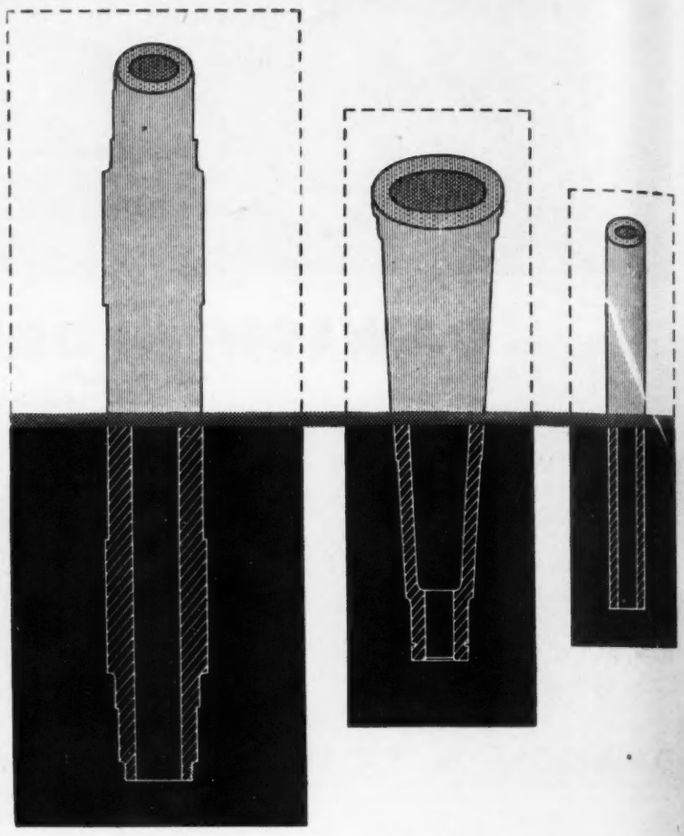

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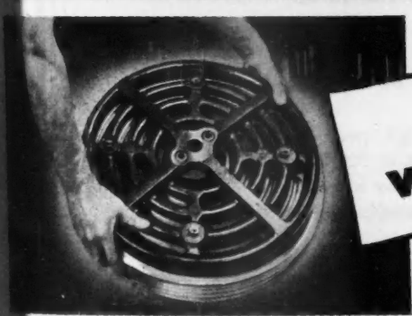
little valves...

medium valves...



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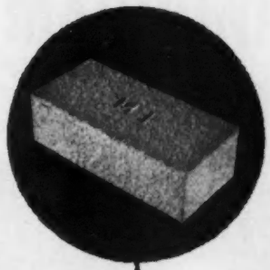

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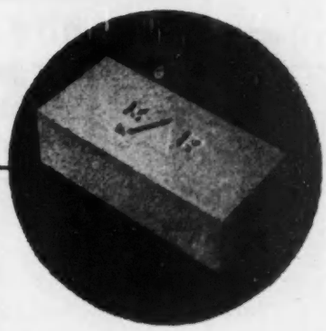

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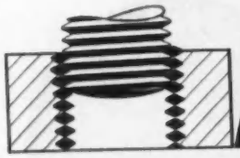

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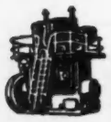

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Engine driven up to 340 kW.
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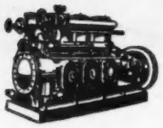

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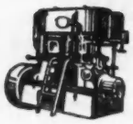

High speed Vertical up to 500 B.H.P.
Many in hand and hundreds in service.

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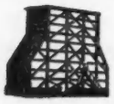

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Nearly 50 years' experience

also Manufacturers of all kinds of

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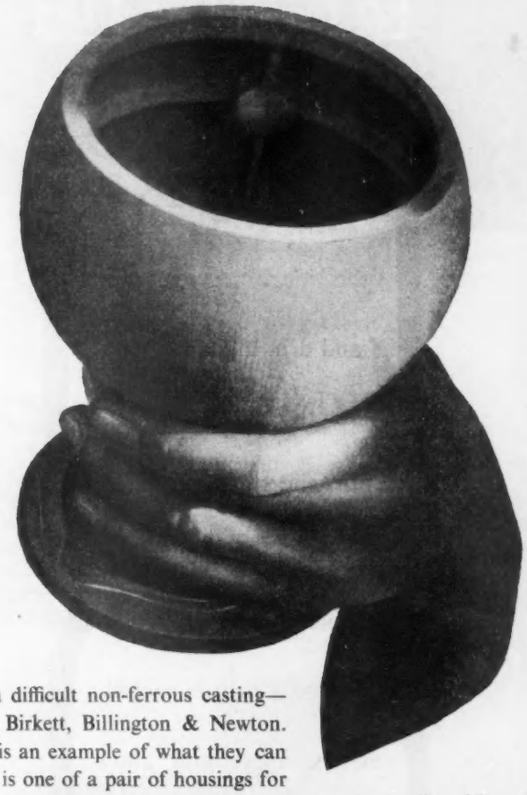
COMPRESSOR & POWER PLANT SPECIALISTS FOR NEARLY A CENTURY

What's yours?



If it's a difficult non-ferrous casting—consult Birkett, Billington & Newton. Above is an example of what they can do. It is one of a pair of housings for the driving shaft of an independently sprung wheel. To withstand severe shocks and stresses it was cast in high tensile manganese bronze and then precision-machined.

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Kilovoltage	79	79	79
Milliamperage	30	30	30
Seconds	30	30	30
F.F.D.	40"	40"	24"
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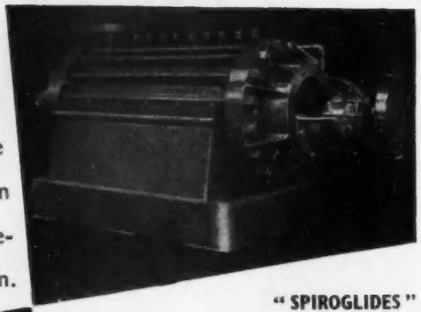

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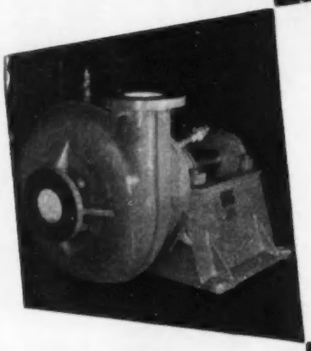

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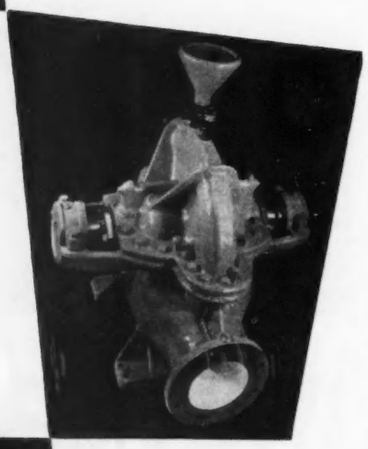

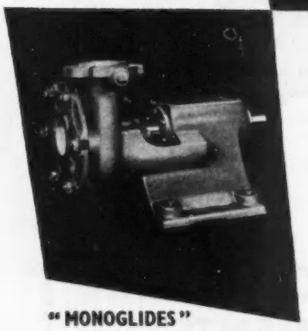

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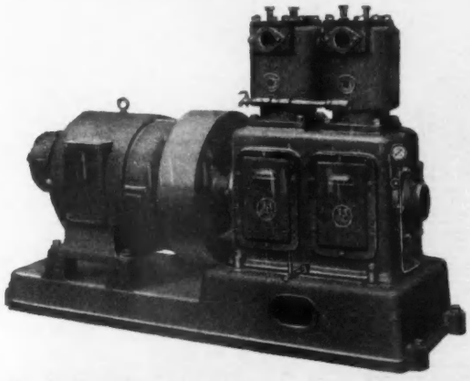

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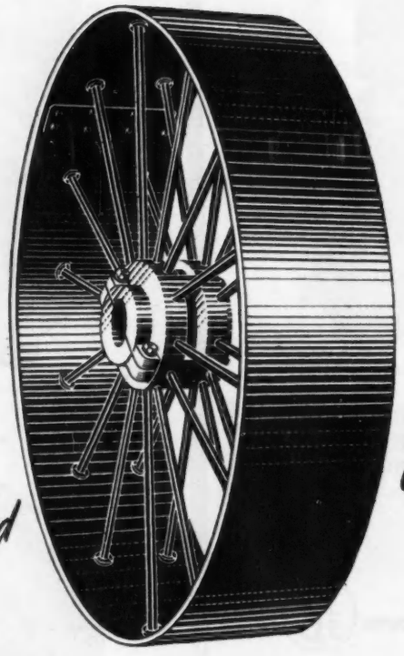

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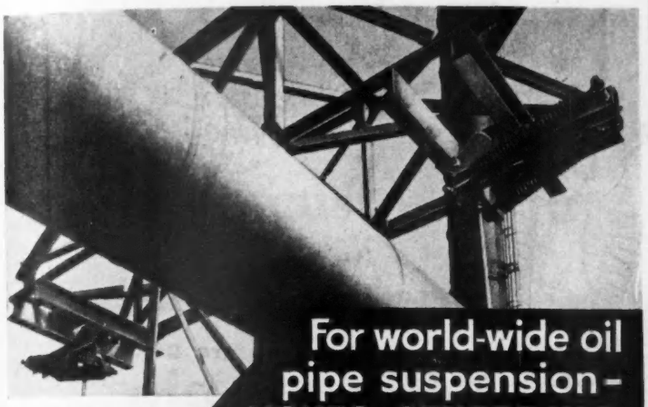

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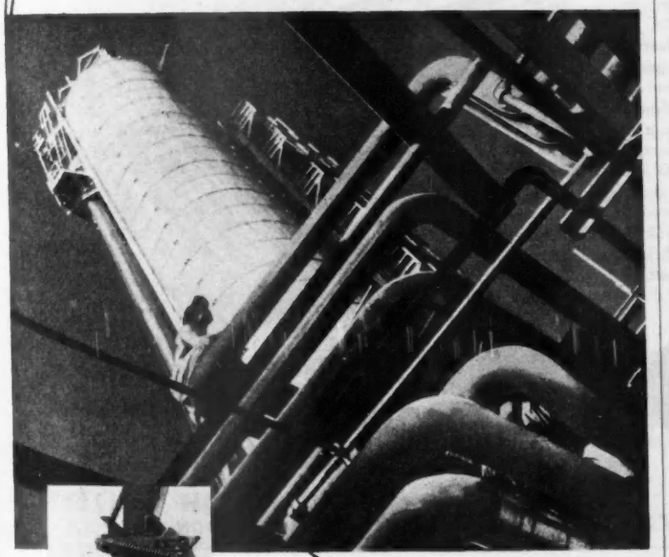
For world-wide oil pipe suspension – VOKES GENSPRING pipe hangers

Throughout the Platforming Unit at the 'Shell' Stanlow Refinery in Cheshire, VOKES GENSPRING Constant Support Hangers are supplying their own incomparable type of support for the piping. Similarly in Aden, where the British Petroleum Company's new refinery came on stream just a year ago, VOKES GENSPRING hangers are used to provide accurate and safe pipe suspension.



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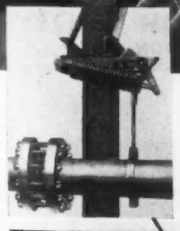

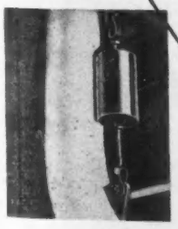

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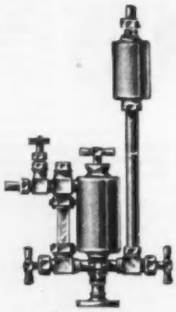

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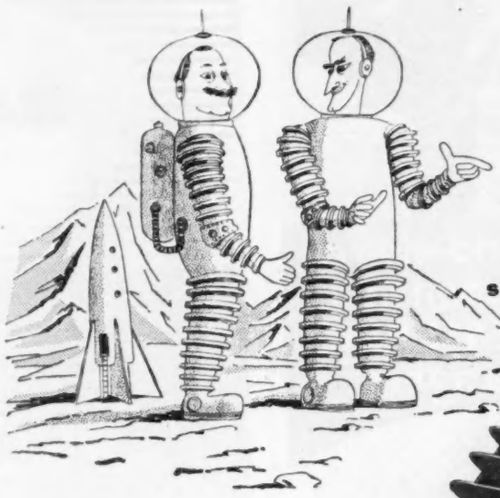

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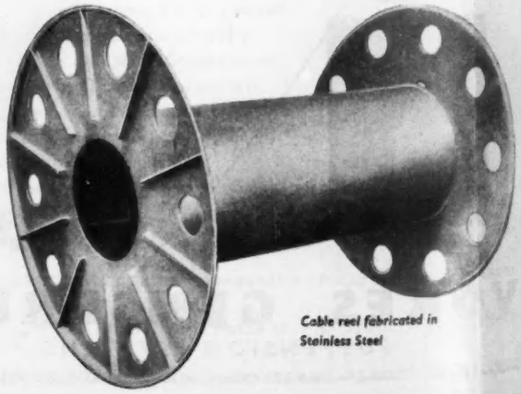

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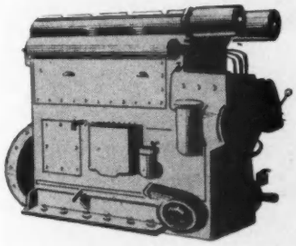

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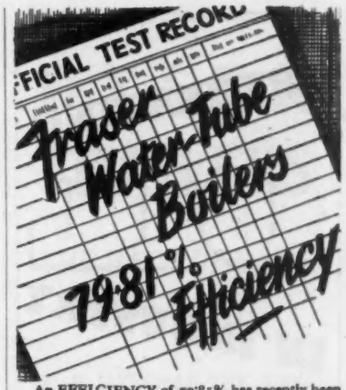

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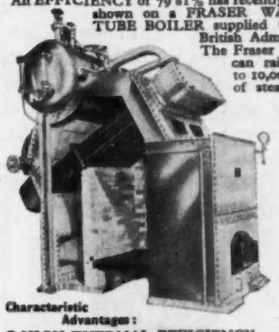

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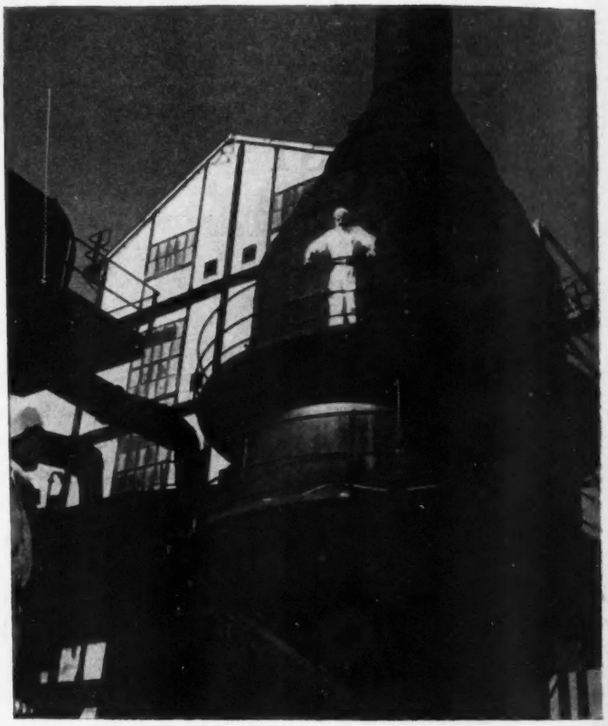

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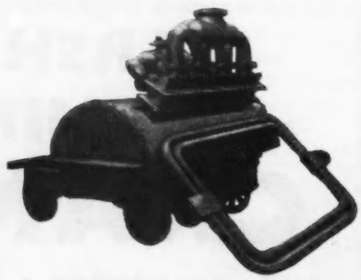

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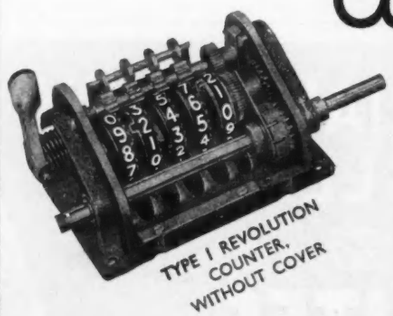

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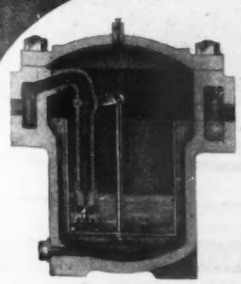

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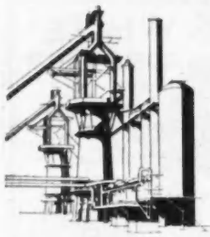

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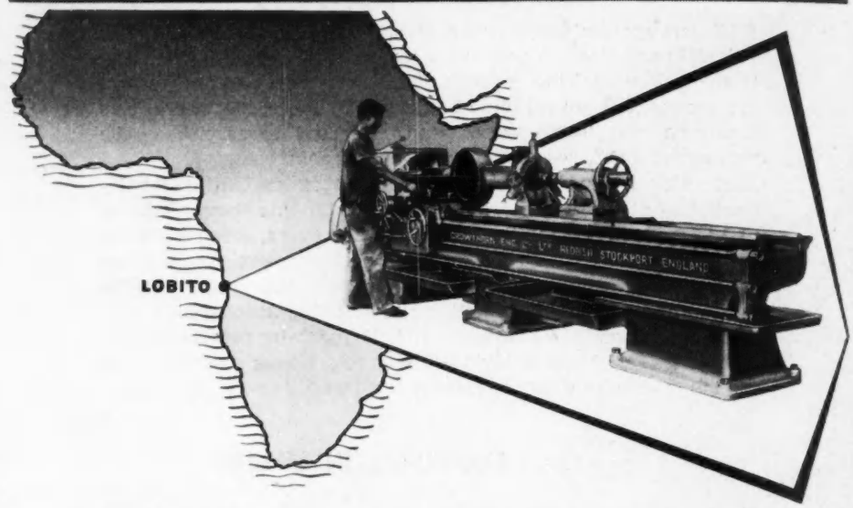

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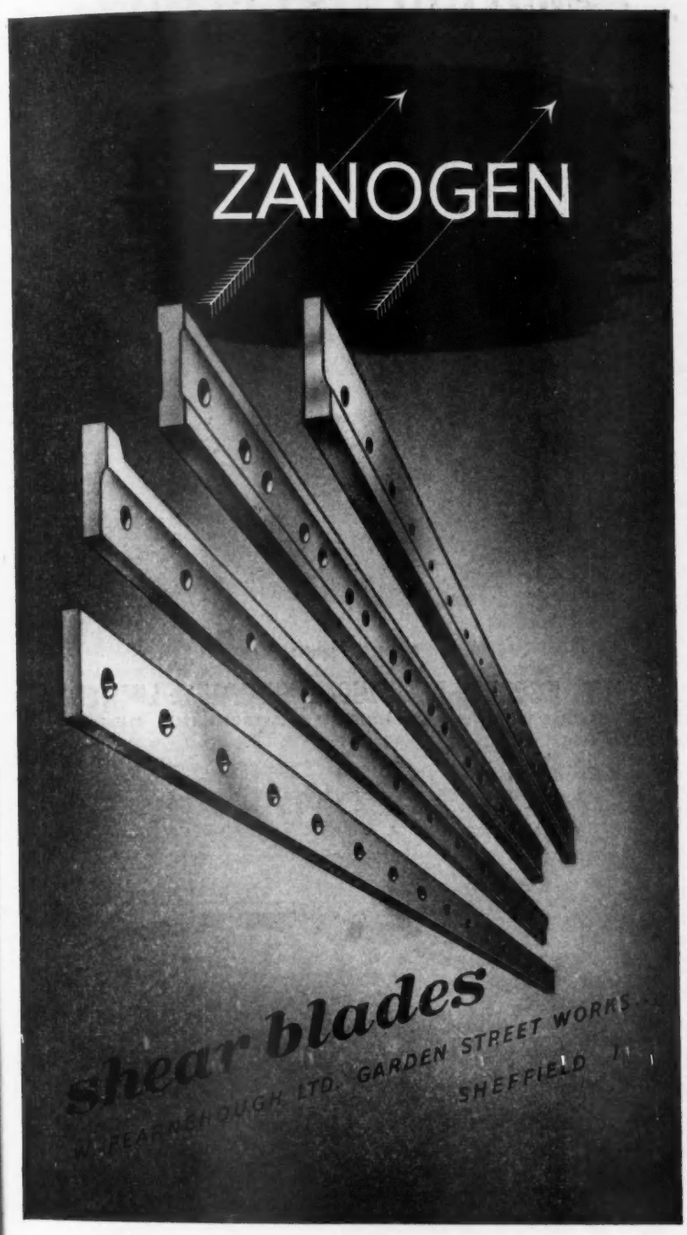

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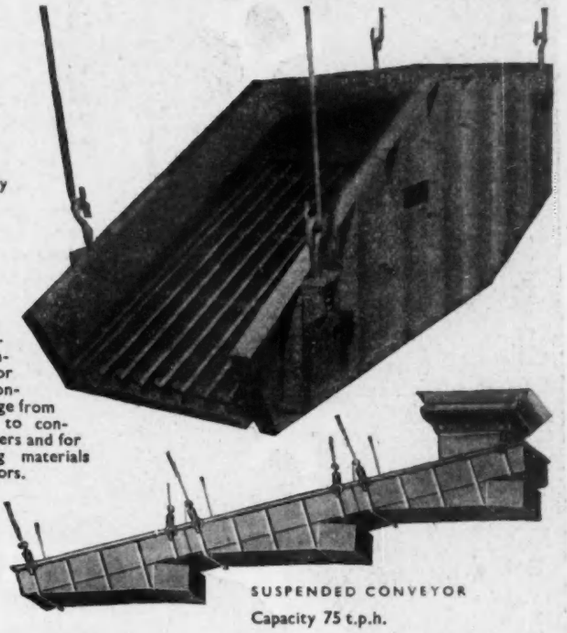

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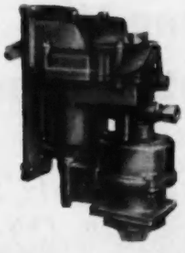

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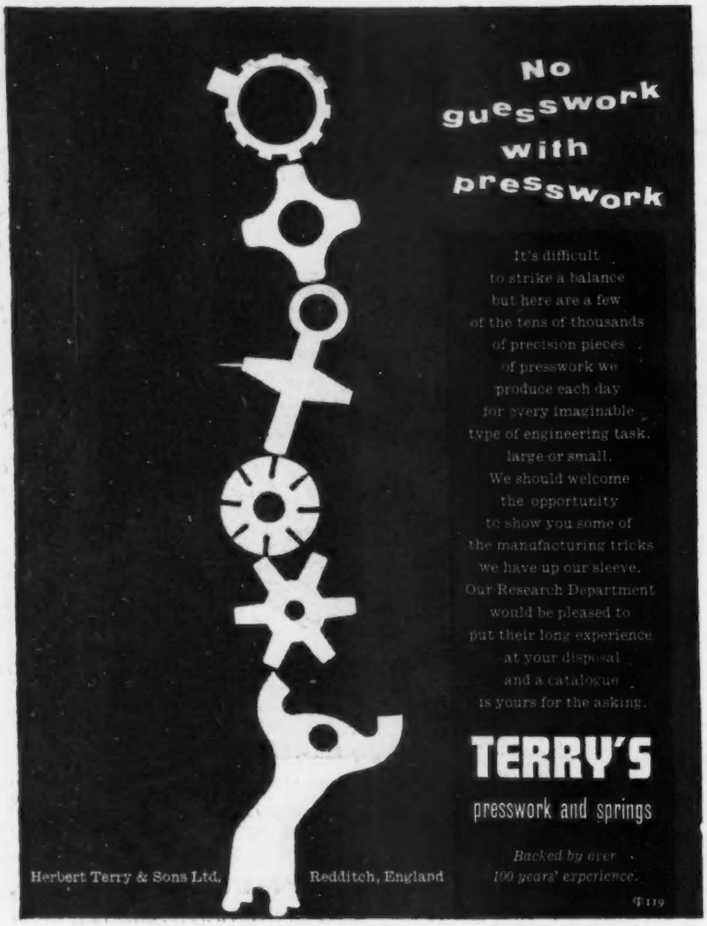
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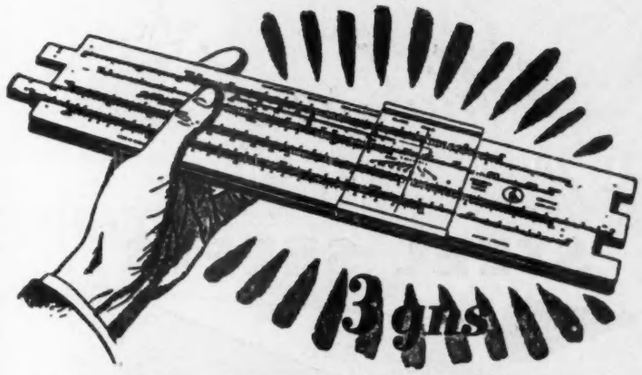

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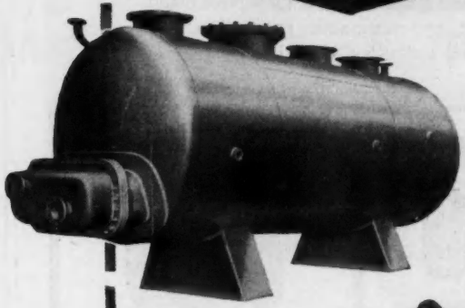

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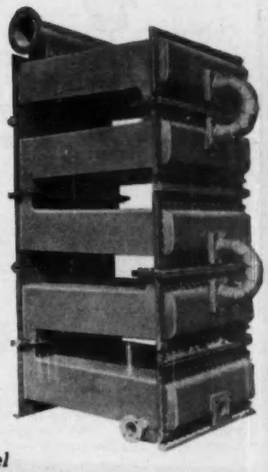

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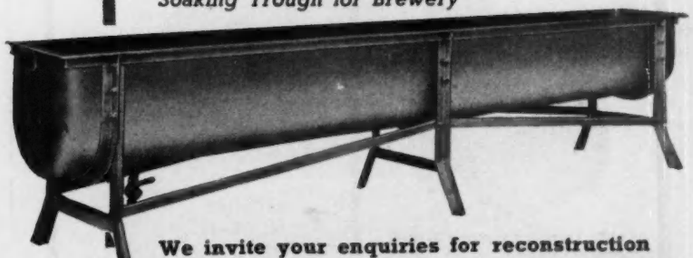

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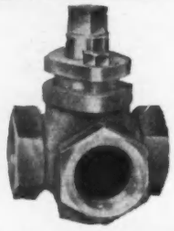

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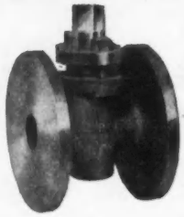

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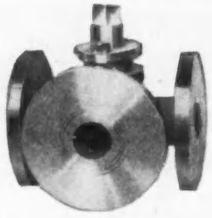

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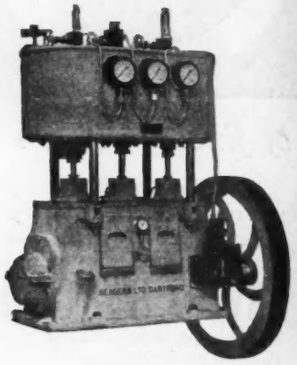

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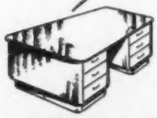

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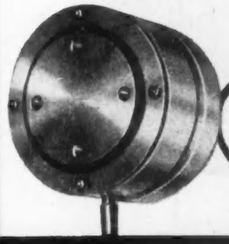

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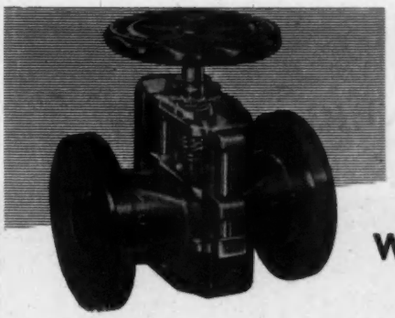

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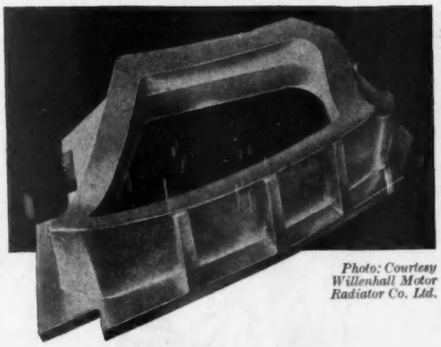

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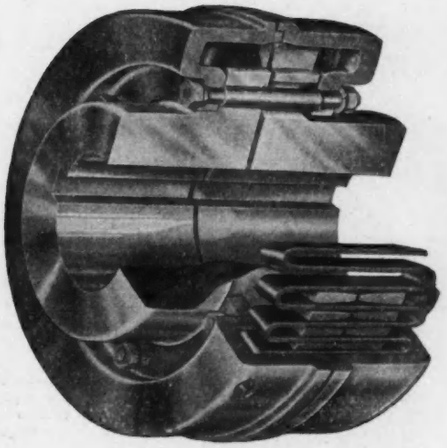

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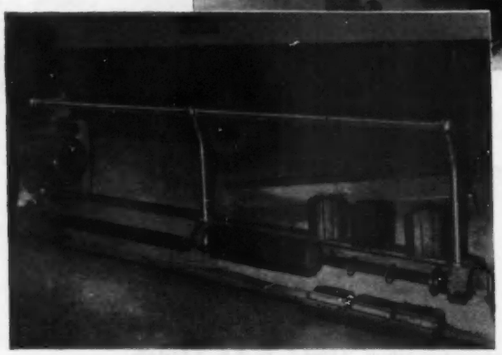

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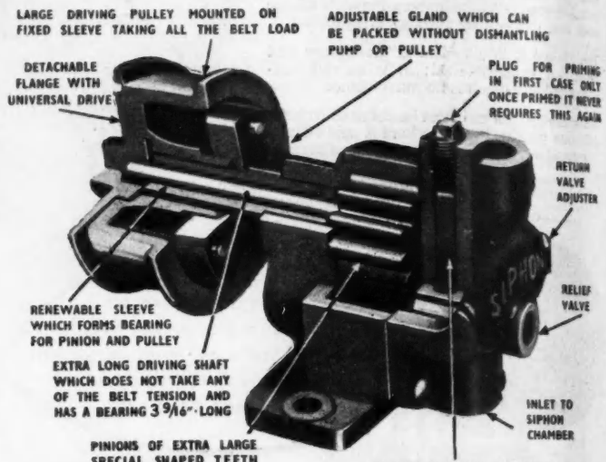
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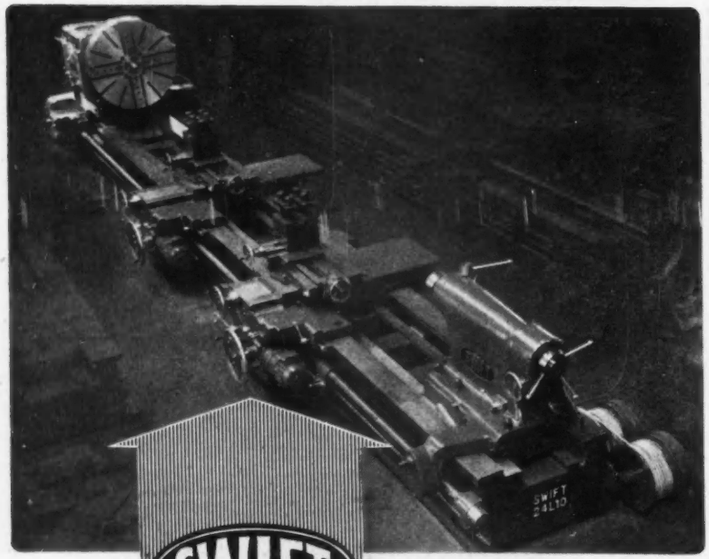

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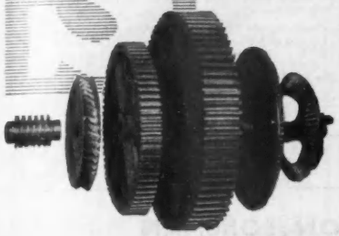

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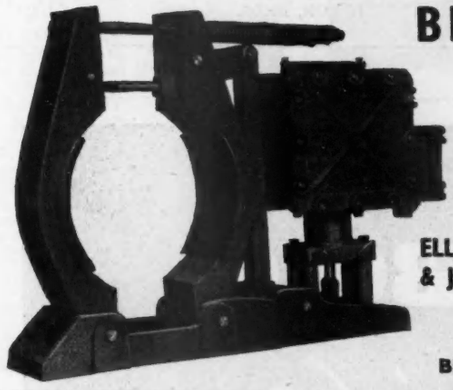

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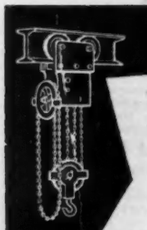

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SCREW LIFTING JACKS
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ROPE PULLEY BLOCKS
WALL HOISTS
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RAIL BENDERS
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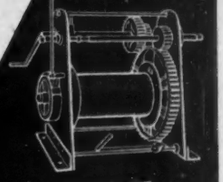

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TELEPHONE: EDGBASTON 3508-9. TELEGRAMS: "OLDENS" BIRMINGHAM

VERTICAL BORING MACHINES
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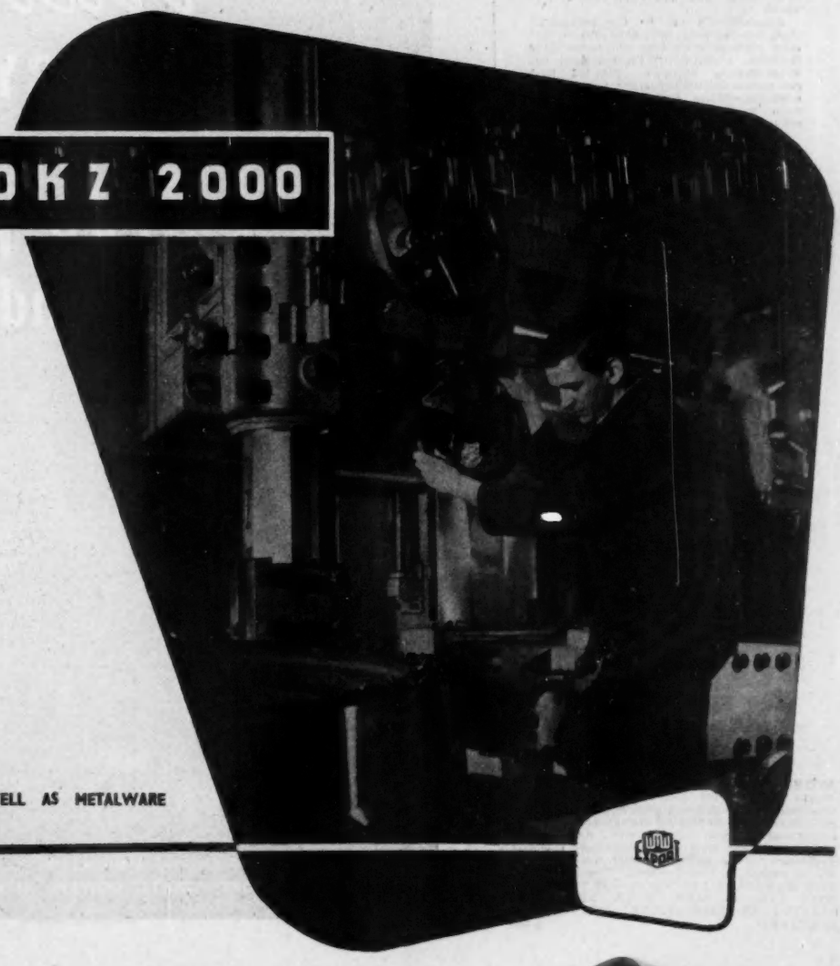
DKZ 2000



Good results are obtainable with our vertical boring machines.

They can deal with large diameter and heavy articles, such as flywheels, turbine housings, cylinders, etc.

The speed of the face plate is the same as the cutting speed.

When high speed tool steel is being used, the cutting speed can also be adjusted to ensure economic utilisation of hard metal tools.

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XPORT UNDERTAKING FOR MACHINE AND HAND TOOLS AS WELL AS METALWARE

Berlin W8, Mohrenstrasse 61

Classified Advertisements continued from Page 8

MECHANICAL ENGINEER, time served, 23/30 years of age, required for production work in old-established Engineering Company in Widnes.

Applications, stating age, qualifications and experience, should be addressed to L 431, Offices of ENGINEERING.

A well-established Industrial Company invites applications from

YOUNG ENGINEERS willing to undergo a period of training to fit them for Management appointments in Production. This is an exceptional opportunity for young men of drive and initiative to reach positions of responsibility in a relatively short time. They must be 26 to 28 years of age and have a University Degree. A salary up to £1000 per annum is offered and the prospect of reaching the £3000 to £4000 level is excellent. Full details of qualifications and experience should be sent in confidence to BOX L 438, Offices of ENGINEERING.

ASSISTANT ENGINEER (GENERATION) required for Power Company in MALAYA. Applicants should have experience in the operation of steam generating plants and have served a full apprenticeship in Mechanical Engineering. Qualifications—H.N.C. Grad. I. Mech. E., or equivalent. Age 25-30. Starting salary (including cost-of-living allowance, £1190-£1500, depending on experience and whether married. Free quarters or an allowance provided. Free return passages and medical attention. There is also a Pension Scheme.—Write BOX EG.160, c/o 191, GRESHAM HOUSE, E.C.2. L 441

IMPERIAL CHEMICAL INDUSTRIES LIMITED,
ALKALI DIVISION,
WINNINGTON, NORTHWICH,
CHESHIRE.

EXPERIENCED DESIGN DRAUGHTSMEN.

Vacancies exist for experienced draughtsmen for employment as Assistant Technical Officers in expanding Instrument Design Sections engaged on large-scale instrumentation projects for chemical processes and power plants. Minimum qualifications are (*a*) an approved apprenticeship to an appropriate trade; (*b*) Higher National Certificate. Candidates must have sound practical and theoretical knowledge of process control techniques using pneumatic and electronic systems, and the aptitude for close co-operation with other engineering design teams and with contractors' and plant personnel. Age 25-40.

Appointments are to the permanent staff, five-day week, with good salaries, first class working conditions and recreational facilities. Contributory Pension Fund and Profit-Sharing Schemes. Married men can receive limited assistance with removal expenses.—Write for official application form to STAFF MANAGER, quoting reference GE8/DESN. L 346

AGENT required for Northern Ireland, by old-established manufacturers of Lifting equipment, embodying Cranes and Overhead Runways, etc. Agent must have engineering experience, and live connection with the industry in Northern Ireland.—Apply to SALES MANAGER, THE VAUGHAN CRANE CO., LTD., WEST GORTON, MANCHESTER, 12. L 422

MECHANICAL ENGINEER.

The ASSOCIATED ETHYL COMPANY, LIMITED has a vacancy for an **ASSISTANT MECHANICAL ENGINEER** in its Engineering Department at Ellesmere Port.

Applicants should be between the ages of 28 and 35, possess a degree in Mechanical Engineering and be corporate members of the Institution of Mechanical Engineers. Drawing Office and Works experience is desirable. The work is concerned with the design and modification of Heavy Chemical Plant and previous experience in this field and the Petroleum industry would be an advantage.

Applications, giving full details, should be sent to :—

MANAGER—STAFF AND TRAINING DEPARTMENT,
ASSOCIATED ETHYL COMPANY, LIMITED,
ELLESMERE PORT,
CHESHIRE,
quoting reference number 171.E.
L 406

WORKS ENGINEER required as Assistant Works Manager for spun concrete pipe works. Qualifications, good sound knowledge of machinery maintenance and mechanical engineering, organising ability and ability to control labour. Knowledge of plant layout and heavy duty machinery essential. Preference for an applicant under the age of 35. Works located in Leicestershire.—Please apply to: THE MANAGING DIRECTOR, JOHN ELLIS & SONS LTD., 21, NEW WALK, LEICESTER, STATING QUALIFICATIONS AND SALARY REQUIRED. L 437

A firm of General Engineers of the highest standing, manufacturing a wide variety of Precision Machinery in the medium to heavy range, intend to appoint an

ENGINEER

with a view to his becoming Production Manager.

The candidate requires qualities of a high order, he will report direct to the Board and his starting salary will be £2500 per year. It is intended that the appointment should ultimately carry a seat on the board.

Only those of this standing should apply. —Write to BOX NO. 9905, c/o CHARLES BARKER & SONS, LTD., 31, BUDGE ROW, LONDON, E.C.4. L 356

ASSISTANT CIVIL ENGINEER required for large integrated Iron and Steel Works. The appointment is initially for duties in connection with a two years' plant extension programme, with permanency on demonstration of ability.

Applicants should preferably be between 25 and 35 years of age and have completed their National Service. They should have had at least three years' practical Civil Engineering experience and be competent in the use of surveying instruments.

Applications, giving full details of education, training and experience, should be addressed to: THE CHIEF ENGINEER, APPLEBY-FRODINGHAM STEEL COMPANY, SCUNTHORPE, LINCS. L 435

CHIEF DRAUGHTSMAN for expanding Light Engineering Company.—Apply, giving full details of training, experience, qualifications and salary required, to W. E. & F. DOBSON, LTD., CHELSEA STREET, NOTTINGHAM. L 428

ESSO DEVELOPMENT COMPANY has a vacancy for an

ENGINEER to advise on the application of Petroleum Products in the Aviation Industry. Applicants for this post should have had a minimum of ten years diversified experience in the Aviation Industry, part of which at least should have been with an engine builder. The situation, which is permanent and pensionable, requires a man of British Nationality who has a flair for dealing with people and is prepared to travel. The salary will depend on the age and qualifications of the successful applicant, but will take full cognisance of the responsibility undertaken. In the first instance candidates should write, giving brief personal details, to the MANAGER, ESSO EUROPEAN LABORATORIES, ESSO HOUSE, ABINGDON, BERKS. L 189

A FLIGHT TEST

group has the following staff vacancies.

(*a*) a man with some mathematical qualifications, and an interest in pre-flight assessment and trials analysis for autostabiliser work.

(*b*) a man with instrument experience for outside servicing and installation.

Some knowledge of servo systems would be an advantage for both posts. Pension scheme.—

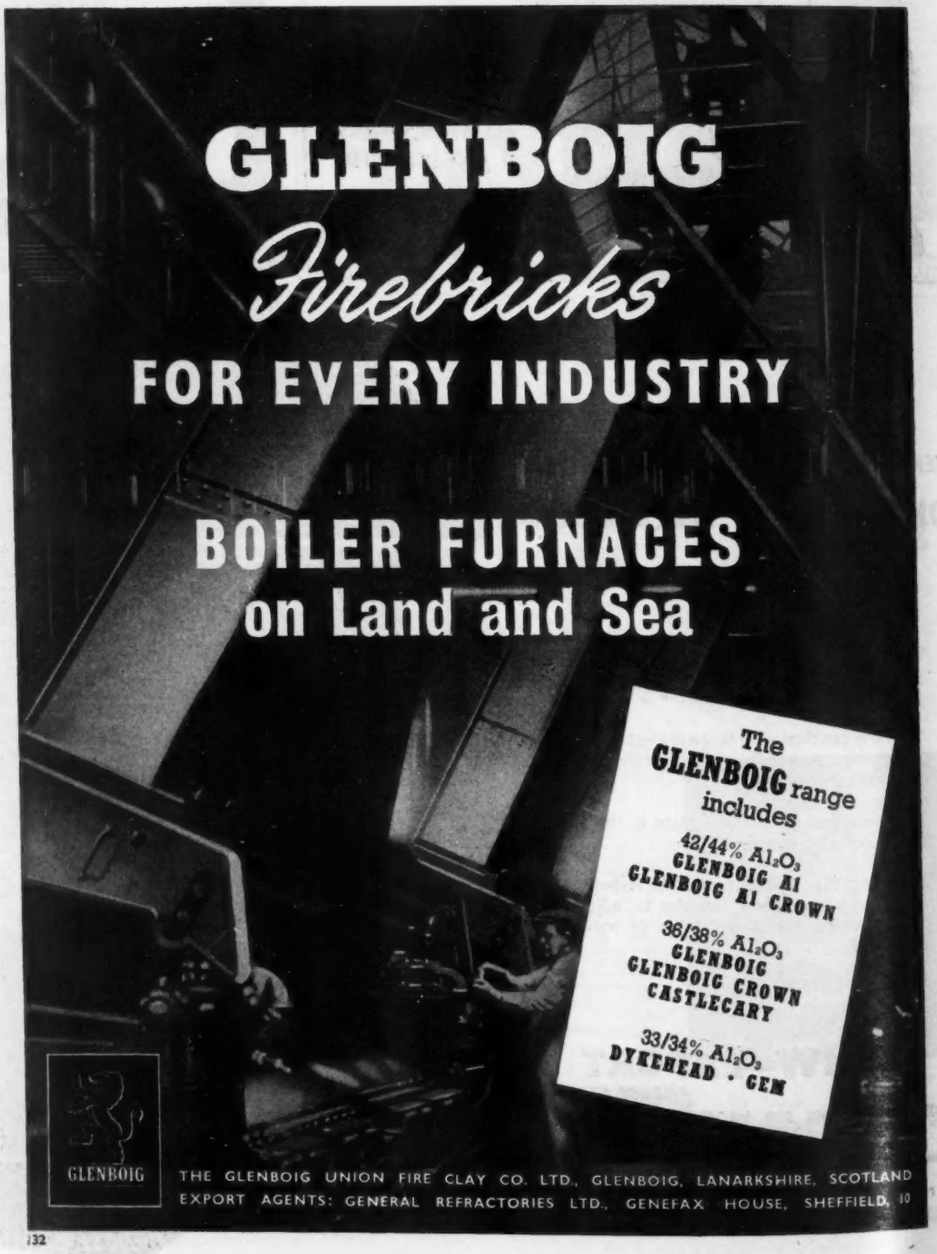
Please apply in writing, giving full particulars, to: PERSONNEL OFFICER, LOUIS NEWMARK, LTD., PREFECT WORKS, PURLEY WAY, CROYDON, SURREY—(Lodge Hill 2131, Extension 21). L 358

STEEL ERECTION FOREMAN

AUCKLAND HARBOUR BRIDGE, NEW ZEALAND.

Experienced Foreman Steel Erector used to heavy bridgework wanted for work in New Zealand. Apply, giving details of experience to :—

CLEVELAND BRIDGE & DORMAN LONG (AUCKLAND),
38-40, BUTE STREET,
LUTON, BEDS. L 451



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The MURAD DUSTLESS GRINDER offers dust protection to both the work and the worker. It embodies a dust inhibitor which renders unnecessary the use of separate dust extractors. It is a complete self-contained unit and can be placed anywhere in the factory to suit individual requirements.

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RUST...

This penetrating oil fluid quickly breaks down rust formation and frees with ease nuts, bolts, screws and all metal held fast by rust. In tins from 4oz to 1 gal.

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Draughtsmen, Draughtswomen and Tracers — Mechanical Engineering.

For Engineering Consultants. Positions are permanent, pensionable, with five-day week. Free lunches. Basic Salary above A.E.S.D. minimum rates, plus profit sharing scheme.

Phone or write, giving details of previous experience, to the

PERSONNEL OFFICER, EWBANK & PARTNERS, LTD., 10/11, GROSVENOR PLACE, LONDON, S.W.1. 200 YARDS HYDE PARK CORNER. SLOANE 0486. G 630

POWER JETS have a vacancy in their Consultancy Department at Farnborough, Hants., for a **JUNIOR ENGINEER** with experience of aerodynamic design of gas turbine components. Preference will be given to applicants having experience of mechanical design. This post offers very varied and interesting work. Five-day week, contributory superannuation, Luncheon Vouchers, three weeks' holiday.—Reply, with full details, in confidence, to THE SECRETARY, 25, GREEN STREET, LONDON, W.1. L 369

LEH REGD TRADE MARK

HYDRAULIC MACHINERY

THE LEEDS ENGINEERING & HYDRAULIC CO. LTD
ROOLEY LEEDS

DESIGN ENGINEER required for South Yorkshire Steelworks Development Engineer's Office. Experience in any of the following would be an advantage: Rolling Mills, Hydraulics, Mechanical Handling, Furnaces or Electronics. Good chances of promotion.—Applications, stating age, experience, etc., to BOX L 403, Offices of ENGINEERING.

A leading Electrical Engineering Company is seeking **A CHIEF PRODUCTION ENGINEER** for its Midlands factory. This is a senior appointment involving responsibility for the complete factory Production Engineering functions including Processing, Ratefixing and Jig and Tool Design on medium and heavy type mechanical electrical products. Only men with wide experience of Production Engineering in machining, fitting and fabrication and with the highest qualities of drive and managerial ability need apply for this important post. The appointment is situated in a pleasant Midland town and will carry a starting salary commensurate with its senior status plus bonus and non-contributory superannuation.—Please apply to BOX L 241, Offices of ENGINEERING.

RESEARCH ENGINEER OR PHYSICIST

with advanced knowledge of thermodynamics required by a Glasgow Engineering Company. Applicants, aged 25-30, should have a University Honours Degree. Experience in heat transfer problems would be an advantage. Salary depending on qualifications and experience.—Apply to BOX G 583, Offices of ENGINEERING.

STRUCTURAL ENGINEER required by London firm of Consultants to take charge of their steel design office. Candidates must have a comprehensive knowledge of all types of structural steelwork both designing and detailing and should preferably have had some works experience. Applicants should be Corporate Members of one of the senior professional Institutions or hold similar Degrees. The post is a permanent one and there is a Staff Pension Scheme.—Please reply in confidence to BOX NO. 389, GLOVERS ADVERTISING, LTD., 351, OXFORD STREET, W.1. G 643

QUALIFIED CIVIL OR MECHANICAL ENGINEER wanted by Consulting Engineers for Middle East. Should have oil experience, preferably of pipelines and pumping stations. Age 35-45. Liberal pay and free quarters.

Apply by letter with full particulars of age, qualifications and experience, to BOX No. 9007, c/o CHARLES BARKER & SONS, LTD., 31, BUDGE ROW, LONDON, E.C.4. L 401

DRAUGHTSMAN required, preferably with experience in power transmission. Five-day week; Pension Scheme.—Apply in writing to the CHIEF DRAUGHTSMAN, THE WELLMAN BIBBY CO., LTD., PARNELL HOUSE, WILTON ROAD, LONDON, S.W.1. L 396

Classified Advertisements continued on Page 132

in the long run the short cut is "SPEEDICUT"

Engineers' cutting tools of all types

F. H. B. T. FIRTH BROWN TOOLS LTD

SPEEDICUT WORKS, CARLISLE STREET EAST, SHEFFIELD

SENIOR MECHANICAL AND STRUCTURAL DRAUGHTSMEN required in London office for the design, layout and detailing of Electric Cranes and Mechanical Handling for Steelworks.—Apply in writing, stating age and experience, to: "THE MECHANICAL DEPARTMENT," THE WELLMAN-SMITH-OWEN ENGINEERING CORPORATION, LTD., PARNELL HOUSE, WILTON ROAD, S.W.1. K 599

AERO ENGINE CONTROL SYSTEM.

ENGINEERS are required for a newly formed department dealing with various theoretical aspects of aero engine control problems. Experience of screw mechanism analysis and for gas turbine engine performance investigation is desirable.—Applications quoting END to TECHNICAL PERSONNEL MANAGER, ARMSTRONG SIDDELEY MOTORS, COVENTRY. G 658

ROCKETS—TEST PLANT DESIGN AND DEVELOPMENT. ARMSTRONG SIDDELEY MOTORS require

ENGINEERS with a Degree or H.N.C. to design and develop Rocket propulsion experimental test equipment. This young division with its future is a worthwhile field both for interest and prospects.—Applications, quoting RTP, to TECHNICAL PERSONNEL MANAGER, ARMSTRONG SIDDELEY MOTORS, COVENTRY. G 659

RESIDENT ENGINEER

to supervise construction of large Iron and Steelworks in India. Considerable similar experience required. Good salary and conditions of employment to the right man.—Apply in writing giving full particulars of age, education, training and practical experience, stating salary expected and when available to BOX L 251, Offices of ENGINEERING.

Also required for same job:—

ONE CIVIL ENGINEER
ONE MECHANICAL ENGINEER
ONE ELECTRICIAN

SENIOR MECHANICAL ENGINEERING ASSISTANT required by London Consulting Engineers. Drawing Office experience also knowledge of marine and/or mechanical engineering essential. Knowledge of dock and harbour plant an advantage.—Write stating age, training and experience to BOX L 304, Offices of ENGINEERING.

A large works in the North West invites applications for the appointment of

MECHANICAL ENGINEER.

Graduate engineers preferred. Age group 30-40. Salary £1500-£1800 depending on qualifications and experience. Membership of a staff pension and life assurance scheme is obligatory and an assisted house purchase scheme is in operation.

Applications with details of experience and qualifications to BOX L 312, Offices of ENGINEERING.

Part-time assistance required by Westminster Consultants for detailing of concrete bridges. Liberal remuneration for experienced **STRUCTURAL DRAUGHTSMAN.** Write in confidence stating age and details of experience.—BOX L 158, Offices of ENGINEERING.

DRAUGHTSMAN required by Consulting Engineers, Westminster, for reinforced concrete bridge work. Salary up to £800 per annum according to ability. Interesting work and excellent prospects. This year's holiday arrangements honoured. Write stating age and details of experience.—BOX L 159, Offices of ENGINEERING.

DRAUGHTSMAN required for Engineering Dept. of Manufacturing concern. Age approx. 24-30. Educated to H.N.C. preferred. Experience in General Engineering, Plant Layout, Buildings, Factory Services, etc. Some electrical experience would be an advantage. Good man capable of working with minimum of supervision would find good conditions of employment, Canteen facilities, pension Scheme etc. Replies giving full details and salary required to MARTIN BLACK & CO. (WIRE ROPES) LTD., SPEEDWELL WORKS, OATBRIDGE. L 137

SENIOR DRAUGHTSMEN required by old-established firm of hydraulic engineers in Cheshire, preferably with design experience in hydraulic presses, valve gear and pumps. Good salary to suitable men. Five-day week, pension scheme and canteen facilities.—Apply in confidence stating age, experience and salary required to BOX L 156, Offices of ENGINEERING.

CONTRACTS ENGINEERS.

A. REYROLLE & COMPANY LTD., of Hebburn, County Durham, who are the largest firm of switchgear specialists in the world, have vacancies for **CONTRACTS ENGINEERS**, both for Home and Overseas contract work on E.H.V. switchgear. In addition, vacancies also exist for Contracts Engineers to handle work in connection with major industrial installations and medium voltage switchgear. The appointment would be for work at Hebburn and it is customary for the Company to appoint engineers for duties in the overseas and home Area Offices from engineers trained at Hebburn. The work requires initiative and affords the engineer individual responsibility. It is interesting and varied and calls for ability to conduct both technical and commercial negotiations. The desirable qualifications are therefore a Degree or a Higher National Diploma or Higher National Certificate, but candidates having an Ordinary National Certificate who are still proceeding with studies could be considered specially. Applicants need not have specialised previously in switchgear, and if necessary, suitable introductory training would be arranged.—Applications, giving full particulars of technical training and previous experience, should be forwarded to the CONTRACTS MANAGER, A. REYROLLE & CO., LTD., HEBBURN, marked "Personal." L19

SENIOR DRAUGHTSMAN wanted for makers of Machine Tools and Sheet Metal Machines. Non-contributory Insurance and Pension Scheme. Age, experience, salary, etc., to F. J. EDWARDS, LTD., 359, EUSTON ROAD, LONDON, N.W.1. L 376

Applications are invited for the following positions in the RICHARDSONS WESTGARTH GROUP:—

CHIEF PRODUCTION ENGINEER (functioning in co-operation with Works Manager) for land and marine steam and gas turbines, large marine diesel engines, condensing plants and auxiliaries, at the Group's four Works, all of which are on the North-East Coast. Applicants must have had a wide and thorough experience of production planning and progressing in heavy engineering of the above or similar character, and must be fully conversant with the best modern practice.

CHIEF MECHANICAL ENGINEER for Richardsons Westgarth (Hartlepool) Ltd., to supervise technical departments dealing with design and operation of large and small steam turbines, gas turbines, condensing plants and feed heating systems for land and marine use; blowers, compressors, etc.

YOUNG TECHNICAL ENGINEERS of degree or H.N.C. standard for interesting work in the fields of design of turbines (steam and gas), heat exchangers and condensers, and testing and servicing large power station equipment.

Good terms of remuneration; pension scheme.

Applications should be sent to the Group's Head Office, addressed to:—
THE MANAGING DIRECTOR,
RICHARDSONS, WESTGARTH & CO., LTD.
(P.O. BOX No. 2),
WALLSEND, NORTHUMBERLAND,
and marked "Appointments; Strictly Confidential." They will not be disclosed without consent. L 54

DESIGNER DRAUGHTSMEN. SEVERAL JUNIOR AND SENIOR DRAUGHTSMEN required, with mechanical and structural experience, by a well-known firm manufacturing steelworks, coke oven and mechanical handling plant. Five-day week. Excellent office conditions. Staff Pension Scheme.—Write stating age, experience and salary required to—CHIEF DRAUGHTSMAN (C), THE WELLMAN SMITH OWEN ENGINEERING CORPORATION, LTD., DARLASTON, SOUTH STAFFS. L 94

SENIOR DRAUGHTSMAN required, London area. Heavy Mechanical Engineering experience essential, knowledge of gearing an advantage.—Write stating age and salary required and giving full details of experience to The SECRETARY, THE POWER PLANT COMPANY LIMITED, WEST DRAYTON, MIDDLESEX. L 89

DEVELOPMENT ENGINEERS AND PHYSICISTS

are required for work in the new and rapidly expanding laboratories of LOUIS NEWMARK, LTD., at New Addington, Surrey. The work includes the design and development of instruments and equipment for the aircraft and allied industries, and some working experience of small electromagnetic instruments is desirable. A degree or similar qualification essential. Good salary based on age and experience. Contributory Pension Scheme.—Apply in writing giving full particulars to: PERSONNEL OFFICER, LOUIS NEWMARK, LTD., PREFECT WORKS, PURLEY WAY, CROYDON. L 326

MACHINE SHOP FOREMAN with special knowledge of gear cutting required for general engineering, Manchester border. Monthly staff status. Pension scheme. Canteen.—Apply in confidence, stating age, experience, etc., to BOX L 409, Offices of ENGINEERING.

UNILEVER LIMITED invite applications for an appointment in the Engineering Department of their London Office as a

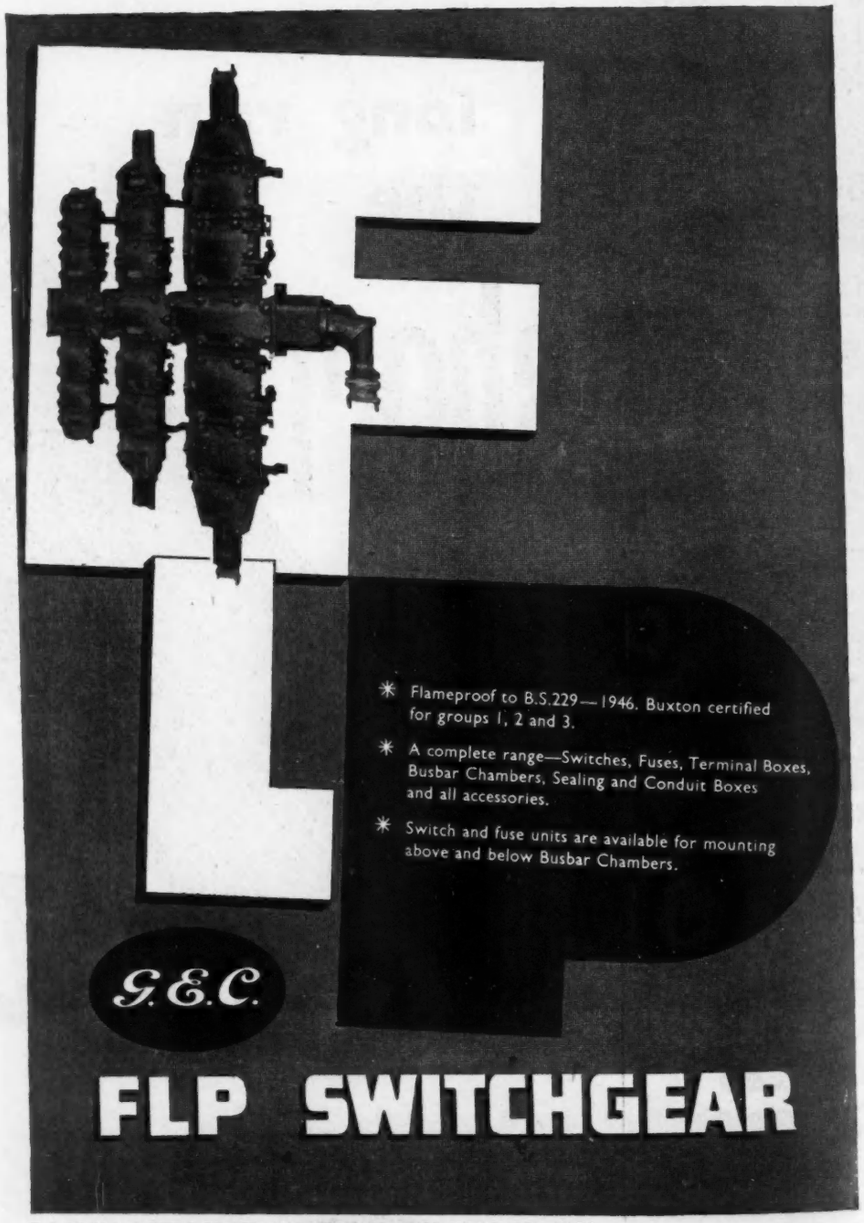
STEAM SPECIALIST. Candidates should be not more than 40 years of age and Corporate Members of the Institution of Mechanical Engineers. They should have had theoretical and practical experience of the thermal design and operation of shell and water tube boiler plant with solid and liquid fuels and of steam distribution systems. Some knowledge of water treatment would be of advantage. Written applications giving full particulars of qualifications, training and experience to be addressed to: UNILEVER LTD., PERSONNEL DIVISION (WAD 115), UNILEVER HOUSE, BLACKFRIARS, LONDON, E.C.4. L 378

SOIL MECHANICS.

ASSISTANT CIVIL ENGINEER required by Westminster consultants. Both theory and practical experience required of soil mechanics as applied to roads, earth dams, etc. Age range preferred 25 to 35. Mobility for short trips abroad helpful. Remuneration will be based on qualifications and experience.—BOX L 379, Offices of ENGINEERING.

DRAUGHTSMEN.

IMPERIAL SMELTING CORPORATION, LIMITED, offers good opportunities to experienced **MECHANICAL AND CHEMICAL DRAUGHTSMEN** for design and detail work in connection with metallurgical and chemical plant and equipment. A wide variety of work is offered and good promotion prospects exist for young men holding or prepared to obtain H.N.C. or equivalent. All appointments are permanent and pensionable with excellent working conditions and amenities.—Write for application form to PERSONNEL MANAGER, IMPERIAL SMELTING CORPORATION LIMITED, AVONMOUTH, BRISTOL, giving brief details of age, qualifications and experience and quoting ref. D/EG. L 421


* Flameproof to B.S.229—1946. Buxton certified for groups 1, 2 and 3.
* A complete range—Switches, Fuses, Terminal Boxes, Busbar Chambers, Sealing and Conduit Boxes and all accessories.
* Switch and fuse units are available for mounting above and below Busbar Chambers.
G.E.C.
FLP SWITCHGEAR
THE GENERAL ELECTRIC CO. LTD., MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

CIVIL ENGINEERING, STRUCTURAL STEELWORK AND REINFORCED CONCRETE DESIGNER required for major development programme. Applicants must be capable of designing all types of structures and heavy plant foundations. Modern drawing office and canteen facilities. Full details of age, technical training and experience and salary required.
Apply LABOUR MANAGER, SAMUEL FOX AND CO., LTD., STOCKSBRIDGE WORKS, NR. SHEFFIELD. L 412

DESIGN DRAUGHTSMAN required by leading AUSTRALIAN Manufacturer of VALVES. A thorough experience in the design of valves up to 36 in. bore size, for water works, pumping stations and water reticulation, etc., is essential. Assistance with migration cost and housing. Commencing salary, £1300 Aust. Superannuation benefits after two years' service.—Write, stating age, experience and qualifications to THE SECRETARY, HATTERSLEY (ORMSKIRK), LIMITED, ORMSKIRK, LANCASHIRE. L 410

SENIOR MECHANICAL DESIGNER/DRAUGHTSMEN, age 30 to 40, required for a large British Managed engineering company in Calcutta, manufacturing cranes of all types and capacities, sluice gates and other irrigation equipment, special machine tools, etc. Excellent prospects and terms for those suitably qualified.—Write BOX AP/126, c/o 95, BISHOPSGATE, E.C.2. L 420

MECHANICAL ENGINEERING DESIGNER-DRAUGHTSMAN required, preferably with experience in Steelworks Hot Mills and Plant design. Modern drawing office, pension scheme and canteen facilities. Replies to state age, technical training and experience with salary required.
Apply LABOUR MANAGER, SAMUEL FOX AND CO., LTD., STOCKSBRIDGE WORKS, NR. SHEFFIELD. L 414

DESIGNER DRAUGHTSMEN required for interesting development work in alloy steelworks producing a variety of semi-finished products. Machine tool or light mechanical experience preferred. Superannuation scheme, good canteen facilities and modern Drawing Office. Applicants to give age, full details of technical training and experience, and salary required.
Apply LABOUR MANAGER, SAMUEL FOX AND CO., LTD., STOCKSBRIDGE WORKS, NR. SHEFFIELD. L 413

Applications are invited for
POSTS IN A RAPIDLY EXPANDING DIESEL ENGINE DEVELOPMENT DEPARTMENT. A very wide range of engines is under development and there is considerable scope for engineers to show initiative. A **SENIOR POST** is available for which a minimum of five years' experience in internal combustion engines is desirable, together with an Engineering degree, as well as a number of **JUNIOR POSTS** for which the minimum qualifications are Higher National Certificates. —Application forms can be obtained from BOX L 415, Offices of ENGINEERING.

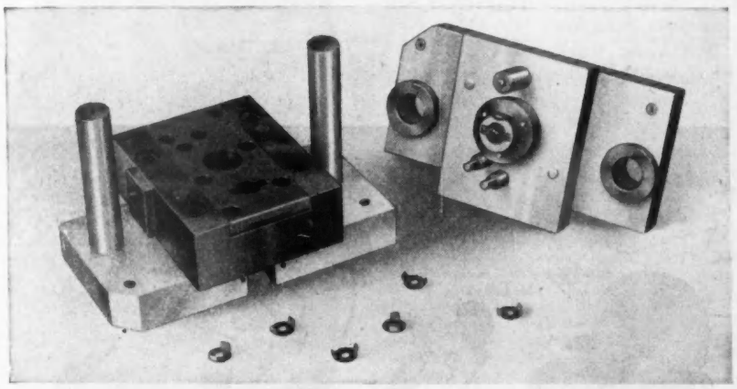
BRITISH INSULATED CALLENDER'S CONSTRUCTION CO., LTD., have the following vacancies in their Overhead Line Contracts Department in London:

ASSISTANT DESIGN ENGINEERS: Work involves structural design aspects of Electrical Transmission and Distribution Lines. Previous experience desirable, although not essential, but structural background up to H.N.C. standard an advantage. After appropriate training successful applicants will be expected to conduct technical correspondence and negotiations. These posts carry progressive responsibility.

DRAUGHTSMEN: To prepare detail and arrangement drawings. These posts would, in suitable instances, offer advancement to the status of Designer Draughtsman.

Attractive salaries will be offered to suitable applicants. Pension Fund, Staff Canteen, Five-day week.—Apply in writing, stating age, to STAFF OFFICER, ABOVE COMPANY, AT 30, LEICESTER SQUARE, LONDON, W.C.2, quoting reference C/90/55. L 416

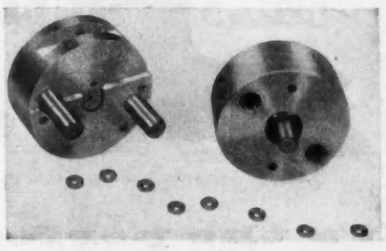
CIVIL ENGINEER—A.M.Inst.C.E. desirable—required by Consulting Engineers to supervise construction work in the North West. Experience R.C. structures essential, also Site Surveys, Measurements, and General Duties. Salary, £750-£950 per annum according to experience. Please write for Application Form to:—KENNEDY & DONKIN (REF. EK), PARK HOUSE, 813A, WILMSLOW ROAD, EAST DISBURY, MANCHESTER, 20. L 390



Press tool for clamping washers in brass. 100,000 produced without regrind. Die: 476 Heavy Duty Die Steel. Punches: Sanderson Non-Distorting Steel. Three-stage tool—1st pierce, 2nd blank, 3rd bend complete.

476 HEAVY DUTY

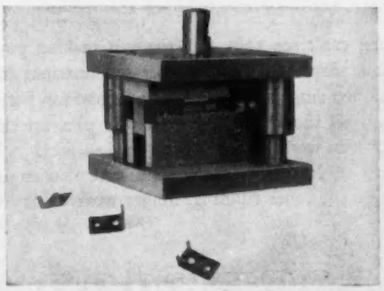
High carbon high chromium die steel for hardening in air or oil. Its abrasion resistance and deep hardening characteristics together with the low movement on heat treatment have led to the wide adoption of this steel for long run dies, particularly on difficult materials. Especially suitable for blanking high silicon transformer sheet, armature discs, stainless iron, zinc, brass, copper.



Punch and die in Sanderson Non-Distorting Steel for production of spring caps in brass in one operation. 30,000 produced without regrind.

SANDERSON NON-DISTORTING STEELS

As pioneers in the introduction of oil-hardening non-distorting carbon-manganese steels seventy years ago, our experience in this branch is without doubt extensive. NEWHALL, the latest development, is a long-wearing steel, hardening with minimum movement at a low temperature and retaining its fine grain and toughness even when badly overheated. For punches and dies, precision tools, cutters.



Tool for producing large braid end connections in one operation. Punch: Sanderson Non-Distorting Steel. Die: 476 Heavy Duty Die Steel.

SANDERSON TOOL STEELS

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SANDERSON BROTHERS AND NEWBOULD LIMITED

P.O. BOX No. 6, SHEFFIELD. STEELMAKERS SINCE 1776

MECHANICAL ENGINEER required to deal with Tenders and Contracts for the supply of Colliery Winders. Excellent opportunity for man with similar experience.—Apply giving full details of training and experience to PERSONNEL MANAGER, THE GENERAL ELECTRIC CO., LTD., FRASER & CHALMERS ENGINEERING WORKS, ERITH, KENT. L 419

OVERHEAD LINE CONSTRUCTION.

SUPERVISING ENGINEER.

MERZ AND MCLELLAN, Consulting Engineers, require an
ASSISTANT CONSTRUCTION ENGINEER to supervise the building of 330-kV steel tower lines in Rhodesia. Candidates must have considerable experience of similar work at voltages of 110 kV and above, and be prepared to climb towers at all stages of construction.
Remuneration depends on age, ability and experience. Pension Scheme. Adequate provision made for cost of living and leave. Home leave after 2½ years, travel paid.
Application, with particulars of education, training, experience, single or married, age and salary required, to MERZ AND MCLELLAN, "MILBURN," ESHER, SURREY. L 417

STEELWORK DESIGNERS.

MERZ AND MCLELLAN require Steelwork Designers for their office at Newcastle-upon-Tyne: (*a*) qualified designers with not less than 5 years experience; (*b*) Junior Designers. These appointments are in connection with the range of Structural Steelwork required in connection with large coal-fired and Atomic Power Stations.—Applications, by letter in the first instance, quoting reference SAR, should be addressed to MERZ AND MCLELLAN, CARLIOL HOUSE, NEWCASTLE-UPON-TYNE, 1. L 392

ENGINEER, MECHANICAL, required by major British Oil Company for general service in the EAST; minimum qualification H.N.C. or equivalent and a recognised apprenticeship, preferably in heavy engineering; previous experience in the Petroleum industry an advantage. Single men not over 28 preferred. Attractive salary, augmented by cost-of-living allowance; kit allowance; free furnished accommodation, passages and medical attention; pension fund.—Write, with full particulars, to BOX EG.140, c/o 191, GRESHAM HOUSE, E.C.2. L 394

CIVIL ENGINEERING DESIGNERS.

MERZ AND MCLELLAN require
(*a*) **A SECTION LEADER** and (*b*) **DESIGNERS** with about 5 years' experience of design and construction in their design office at Newcastle-upon-Tyne, for work in connection with the large variety of Civil Engineering Structures associated with big coal-fired and Atomic Power Stations for public electricity supply.
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DESIGNER DRAUGHTSMAN for work of considerable interest on the design of special-purpose machinery and equipment for automatic manufacture and assembly of the company's products. Excellent working conditions and a contributory Pension Scheme. Employment will be in the Walsall area. Applications will be dealt with in strictest confidence.—Particulars of age, experience, qualifications and salary, quoting reference "A," should be addressed to the PERSONNEL MANAGER, T.I. (GROUP SERVICES), LIMITED, ROCKY LANE, ASTON, BIRMINGHAM, 6. L 397

DESIGNER DRAUGHTSMAN required by Kuwait Oil Company in London Office for design work covering industrial structural and marine engineering, water services and sewerage disposal, and to undertake normal civil engineering drawing office work. Age 30-50. Matriculation standard of general education. Salary commensurate with age, experience and qualifications. Luncheon vouchers and non-contributory pension scheme. Current year holiday commitments recognised up to two weeks.—Write for application form quoting L.O.218, to BOX W/127, c/o 191, GRESHAM HOUSE, E.C.2. L 395

SENIOR JIG AND TOOL DRAUGHTSMEN required for Tool Design on
(*a*) Small I.C. Engine components.
(*b*) Fuel Injection and Hydraulic Control Mechanisms on a production basis.
Applicants should have experience in these or similar fields.
Pleasant working conditions. Generous salary commensurate with qualifications demanded. Attractive pension scheme. Comprehensive welfare facilities.
Apply to CHIEF PERSONNEL OFFICER, BRYCE BERGER WORKS, STAINES, MIDDX. G 660

EXPERIENCED PLANNING ENGINEERS required for production methods on medium I.C. engine components and fuel injection equipment. Pleasant working conditions, generous salary. Attractive Pension Scheme and Comprehensive Welfare Facilities.
Apply CHIEF PERSONNEL OFFICER, PETTERS LIMITED, CAUSEWAY WORKS, STAINES, MIDDX. G 662

SITUATIONS WANTED.

A.M.I.MECH.E., 34, experienced in pumps, compressors, fans. Desires post in Central London. —BOX L 446, Offices of ENGINEERING.

Classified Advertisements continued on Page **134**

HELP! MAN 31, H.N.C. (Mech.), B.Sc. (Struct.) Apprenticeship, 7 years' draughting, aero., genera' engineering, 2½ years laboratory tests, present drawing, seeks change to more active, responsible work. Money secondary consideration.—BOX L357, Offices of ENGINEERING.

WANTED.

WANTED.

WE ARE BUYERS of all types of new ball and roller bearings in large quantities.—C.S.M., 39, AVENUE DE GENERAL LECLERC-LA GARENNE (SEINE), FRANCE. Telephone: CHA. 48-68. G 606

48-IN. "WEBSTER & BENNETT" VERTICAL BORER, must be of modern design.—BOX L 386, Offices of ENGINEERING.

WANTED

STEEL CHANNELS.

5 in. by 2½ in. by 10.22 lbs. per ft.
6 in. by 3 in. by 12.41 lbs. per ft.
7 in. by 3 in. by 14.22 lbs. per ft.
7 in. by 3½ in. by 18.28 lbs. per ft.
8 in. by 3 in. by 15.96 lbs. per ft.

STEEL PLATE.

10 ft. 0 in. by 5 ft. 0 in. by ¼ in. plate.
10 ft. 0 in. by 5 ft. 0 in. by ⅜ in. plate.
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Please quote quantities and prices in the first instance to BOX G 1, Offices of ENGINEERING.

WANTED.

DISCARDED UNGALVANISED STEEL WIRE ROPE. Large quantities 4½ in. to 5½ in. circumference in 6/19, 6/24 or 6/37 normal construction and preferably in 100/110 tons tensile, but would consider other tensiles. Please send prices and lengths.—APPLEBY-FRODINGHAM STEEL CO., BRANCH OF THE UNITED STEEL CO's. LTD., SCUNTHORPE, LINCS.
Telephone No.: Scunthorpe 3411. L 162

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WORK WANTED FOR ACME GRIDLEY BAR AUTOMATIC, 4-spindle, 2¼-in. diameter capacity, 6½-in. maximum piece length.—K. & L. STEELFOUNDERS & ENGINEERS, LTD., LETCHWORTH, HERTS. 'Phone: Letchworth 1630. L 230

QUALIFIED DESIGN ENGINEERS. Mechanical and Process Engineering. Projects or items of equipment designed or detailed.—Apply BOX L 48, Offices of ENGINEERING.

ROSSER & RUSSELL LTD.
GENERAL ENGINEERS,
QUEEN'S WHARF,
HAMMERSMITH, W.6.
'PHONE: RIV. 4416.

MANUFACTURERS OF SPECIAL AND PROTOTYPE MACHINES.

STEEL FABRICATION
&
PROFILE CUTTING.

GENERAL MACHINE WORK.
G 57

AGENCIES.

ENGINEERING AGENTS wide experience and excellent connections, are prepared to follow up quotation in the South Wales area.—BOX G 551, Offices of ENGINEERING.

CAPACITY WANTED

The Advertiser is looking for additional **ENGINEERING CAPACITY** to deal with the complete manufacture of about £250,000 worth of high-class precision machinery of medium weight for delivery in 1958. We should be interested in dealing with this matter on a sub-contracting basis, or alternatively we would consider the outright or part purchase of an Engineering Company. The weight of individual pieces in the machinery required goes up to about ten tons, and the total weight of machines say twenty to twenty-five tons. Our requirements may well go on into 1959, 1960, and future years. No design work is necessary. Very large planing and boring capacity is an essential, and a foundry would be an advantage. Replies and any subsequent negotiations must be on a strictly confidential basis.—Reply to Chairman, BOX L 436, Offices of ENGINEERING.

CAPACITY AVAILABLE.

ACCURATE MACHINING
also on Models and Prototypes, &c.
MILLING TURNING
JIG BORING PLANING
PRESS TOOLS, JIGS AND FIXTURES
HORIZONTAL BORING
GIVE US YOUR DIFFICULT JOBS.
LANDEN (ENGINEERS) LTD.,
1A, AUBERT PARK, LONDON, N.5.
CANonbury 1075. G 620

ARC, GAS, AND STUD WELDING CAPACITY AVAILABLE. Light and Heavy Gauge work.—Details to A. ARENSON, LTD., BARNET TRADING ESTATE, PARK ROAD, HIGH BARNET. BARnet 4501. L 138

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DOUBLE-CHAIN FOUR SPEED DRAW-BENCH by Sir James Farmer Norton for sale. 10 tons pull, 50 tons breaking strength. Suitable for nickel-chrome tubes up to 1½ in. dia. by ⅛ in. thick by 20 ft. long when drawn. Gearbox with flexible coupling for high and low speeds. Two sets air-operated plug-pushing gear with air cylinders, etc. Motorised 35 h.p., 750 r.p.m., 400-440/3/50. Photo and full details from—F. J. EDWARDS, LTD., 359, EUSTON ROAD, LONDON, N.W.1. L 377

PENSOTTI 5ft. Motor Driven
High Speed
VERTICAL BORING MILLS

with taper turning and screw cutting attachment. Max. swing 62 in. dia. Rapid power traverses. 16 speeds from 4 to 145 r.p.m. Motor 28 h.p. Approx. weight 10 tons. 1951-2 machines in excellent condition.

F. J. EDWARDS LTD.,
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EUSton 4681 G 610

B.C.S.

500 H.P. UNUSED DOUBLE DRUM HAULAGE by Uskside Engineering Company (motor not included); rope speed 8 m.p.h. Each drum will hold 3300 yards of 1 in. rope. Complete, mounted on steel base frame work.
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Tel.: CARDIFF 29246. K 915

FOUR STAINLESS STEEL HORIZONTAL BAND COOLING CONVEYORS, 53 ft. 0 in. centres (effective length 50 ft.) by 32 in. wide by 0.04 in. 8.8. bands. Belt speed 50 ft. per minute. Cooling by water sprays with galvanised tanks, etc. Top of belts 4 ft. 0 in. from floor level. Air cooling above the belts by galvanised ducts complete with fans and motors. Three conveyors are new and unused, one has been in commission for a short time. The conveyors are for disposal, due to a rearrangement of plant. Drawings can be supplied, together with a full specification and inspection arranged if required.—Apply BOX L 418, Offices of ENGINEERING.

B.C.S.

ONE—600 K.W. SULZER DIESEL GENERATING SET, 220/440 volts, D.C. complete with Auxiliaries, Spares, etc.
ONE—850 K.W. SULZER DIESEL ALTERNATOR SET, 400/440 volts, 3 phase, 50 cycles, 428 r.p.m., complete with Auxiliaries, etc.
ONE—325 K.W. PAXMAN/CROMPTON PARKINSON DIESEL ALTERNATOR SET, 400/440 volts, 3 phase, 50 cycles, 1000 r.p.m., complete with Auxiliaries and Spare Parts.
ONE—265 K.W. PAXMAN/B.T.H. DIESEL ALTERNATOR SET, 400 volts, 3 phase 50 cycles, 1000 r.p.m., complete with Auxiliaries and Switchboard.
ONE—80 K.W. GENERAL MOTORS/HOUCHIN DIESEL ALTERNATOR SET, 400/440 volts, 3 phase, 50 cycles, 1500 r.p.m., complete with all Auxiliaries and Switchboard.
ONE—55 K.W. McLAREN/BRUSH DIESEL ALTERNATOR SET, 400/440 volts, 3 phase, 50 cycles, 1000 r.p.m., complete with Auxiliaries and Switchboard.
ONE—40 K.W. SENTINEL/LEROY DIESEL ALTERNATOR SET, 400/230 volts, 3 phase, 50 cycles, 1500 r.p.m., complete with Auxiliaries and Spare Parts. New 1951.
TWO—20 K.W. HILL & CO./DELCO DIESEL GENERATING SETS, 120 volt D.C., 1450 r.p.m., complete with Auxiliaries.
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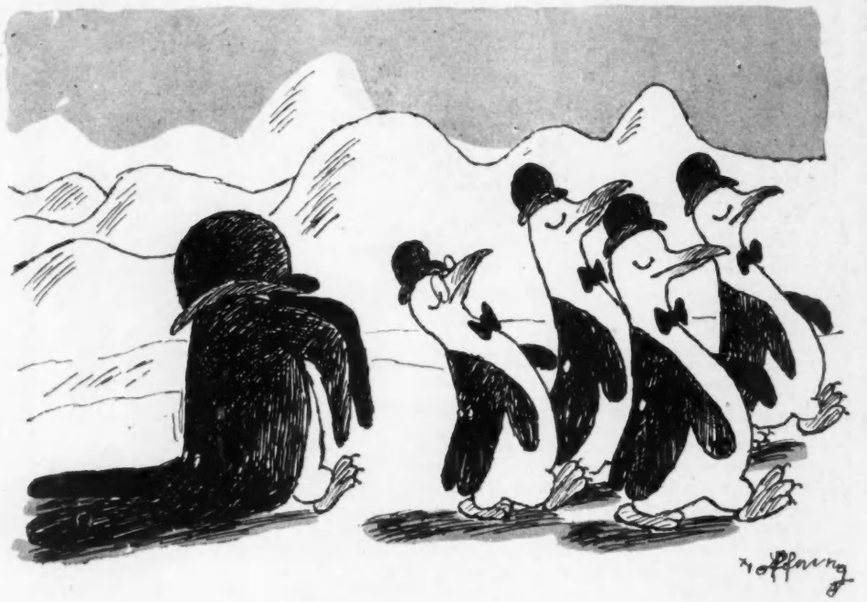
Tel.: CARDIFF 29246. K 912



It's the perfect fit

that means so much

If you can't see your way towards making power economies, think of L. & C. diesel piston rings—all the best-dressed marine engines have them. These perfectly tensioned rings are ready-made to give top performance the whole time. They fit snugly all round with an even wall pressure that hems in the power and puts *all* of it to work. More thrust for less fuel.
There are L. & C. piston rings to suit your engines down to the ground and to give smoother running, longer wear. May we send you a catalogue?

LOCKWOOD & CARLISLE LTD

Manufacturers of the well-known "Patent Double Action Piston Rings" for steam engines

MAKERS OF THE WORLD'S FINEST DIESEL PISTON RINGS

EAGLE FOUNDRY · SHEFFIELD 11 · ENGLAND PHONE: 63207 (3 LINES) GRAMS: PISTON, PHONE SHEFFIELD

There's no escaping it— Wrought Iron is safer

All threats to human safety are not as clearly evident as this one. Many daily dangers are unseen and unsuspected—such as the possibility of failure by couplings, cable chains and cage and lifting gear. *Where equipment of this kind involves the lives of men and women, it is safer to specify Wrought Iron.* Wrought Iron is very tough indeed. Its shock and strain resistance is outstanding. Its ability to withstand rust and corrosion is well known. And its inherent susceptibility to welding is intensified by slag inclusions. These qualities add up to an all-round, long-term superiority to mild steel for many purposes, in both safety and economy—especially where wet or outdoor conditions are concerned. At the Midland Iron Works we produce Wrought Iron in strips and bars, and in a variety of sections, for innumerable uses. We will gladly send you a free copy of our Section Book, and our technical representative is at your service for consultation on Wrought Iron application.

This nick-and-bend test piece clearly shows the fibrous structure of Wrought Iron, which gives it its high durability, shock-resistance and ability to absorb varying stresses and withstand severe vibrations. Wrought Iron is also distinguished by its ductility and exceptionally good machining properties.

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...you can safely use Wrought Iron for a host of purposes

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AIR COMPRESSORS

303 C.F.M. REAVELL TSA 9 WATER COOLED, 100 p.s.i., with 85 h.p. Met. Vick. 3-phase slip ring motor and starter.

THREE 250 C.F.M. BELLISS & MORCOM WATER COOLED, 100 p.s.i., fitted flywheel 36 in. by 9 in., for belt drive.

150 C.F.M. INGERSOLL-RAND AIR COOLED TYPE 40, 100 p.s.i., with 40-h.p. Crompton 3-phase slip ring motor, starter. Combined baseplate.

64 C.F.M. C.P.T. TYPE PB2 AIR COOLED, 100 p.s.i. with 20-h.p. Crompton "Tork" motor and starter.

NEW 11½ C.F.M. BROOMWADE AUTOMATIC PLANT, AIR COOLED, 100 p.s.i., with 4-h.p. 3-phase motor, Igranic switch and starter, all mounted on 5 ft. by 20 in. horiz. receiver.

7.3 C.F.M. BULLOWS AUTOMATIC PLANT, AIR COOLED, 250 p.s.i., with 2-h.p. 3-phase motor, pressure switch, etc., all mounted on 4 ft. by 18 in. horiz. receiver.

7 C.F.M. BROOMWADE AUTOMATIC PLANT, AIR COOLED, 100 p.s.i., with 3-h.p. single phase motor, Igranic switch, etc., all mounted on 4 ft. by 18 in. horiz. receiver.

NEW BROOMWADE N.2 AIR COOLED UNIT, 11½ c.f.m. 100 p.s.i., 9.3 c.f.m. 200 p.s.i., grooved flywheel.

NEW BROOMWADE N.1 AIR COOLED UNIT, 7.1 c.f.m. 100 p.s.i., 5.6 c.f.m. 200 p.s.i., grooved flywheel.

Inspection at THAMES ROAD, SILVERTOWN, E.16.

THOS. W. WARD, LTD.,

BRETTENHAM HOUSE, LONDON, W.C.2.
Temple Bar 1515 (12 lines).

Remember — Ward's might have it!

G 60

THREE LANCASHIRE BOILERS

30 ft. by 9 ft.; 200 lb. W.P.; built 1953; in unused condition; complete with Economiser; Low price for prompt clearance.

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Offices of ENGINEERING.

B.C.S.

22,000 BABCOCK & WILCOX C.T.M. STEEL CASED WATER TUBE, 260 lb. with Superheater, Economiser by Green, Chaingrate Stoker. All mountings.

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TWO—14,000 JOHN THOMPSON 4 DRUM WATER TUBE, 250 lb. with Senior Economiser. All mountings.

30 FT. BY 8 FT. 6 IN. LANCASHIRE BY YATES & THOM, 160 lb. All mountings.

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TWO 16/20 H.P. RUSTON-HORNSBY DIESEL LOCOMOTIVES, 24 in. gauge in first-class condition.

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Classified Advertisements continued on Page 136

SOAG *Rebuilt and Guaranteed*

NILES HORIZONTAL BORER

Late type machine, flanged motor drive, automatic continuous feed facing head, screwcutting attachment, with outer stay.

MODEL WV9
for immediate delivery.

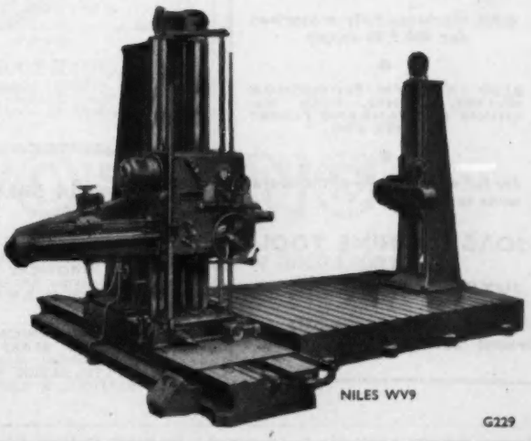
Spindle dia. - -	3½ in.	Facing capacity - -	35½in.
Max. Spindle traverse in one setting -	31½ in.	Facing head dia.- -	24in.
M.T. in spindle -	5	Travel of column -	51in.
		H.P. of motor - -	10

We also have in stock the following Table Type Horizontal Borers: Kearns 'S'; Kearns No. 1 'Standard' type; Kearns No. 2 'Patent' type; Pearn-Richards No. 4; Scharmann HBSF 3 (4in. spindle).

Full details on any of the above gladly sent on request.

SOAG MACHINE TOOLS LTD., JUXON ST., LONDON, S.E.11

Phone: RELiance 3373.



NILES WV9

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SOAG

SELECTED ITEMS
FROM OUR STOCKS OF LATE TYPE HIGH-CLASS
MACHINE TOOLS

HORIZONTAL BORERS
PEARN-RICHARDS No. 4 "STANDARD TYPE."
SCHARMANN HB8F3, 4 in. diameter spindle.
KEARNS No. 2 "PATENT TYPE," with live spindle.
KEARNS No. 1 "STANDARD TYPE."
KEARNS S Type, with collet type chuck.
WOTAN B85, 3½ in. spindle. NEW.
NILES WV9 FLOOR TYPE, 3½ in. dia. spindle.

VERTICAL BORING MILLS
COLBURN 5 ft. DOUBLE COLUMN.
ARMSTRONG CRAVEN 48in. DOUBLE COLUMN.
RICHARDS 48 in. DOUBLE COLUMN.
HARTMANN 43½in. SINGLE COLUMN.
GISHOLT 42 in. DOUBLE COLUMN.
RICHARDS 36 in. DOUBLE COLUMN.
RICHARDS 36 in. DOUBLE COLUMN, with side head.
BULLARD 36 in. SINGLE COLUMN.
BULLARD 24 in. SINGLE COLUMN.

MILLING MACHINES
CINCINNATI 18 in (Plain), table 27 in. by 7½ in.
BROWN & SHARPE 2 (light type plain), table 44 in. by 10 in.
BROWN & SHARPE 2B (Standard Plain), table 51½ in. by 11⅛ in.
PEDERSEN VPF2 (Plain), NEW. Table 51 in. by 12 in.
ROSCHER & EICHLER III (Plain), table 55 in. by 14 in.
CINCINNATI No. 4 Medium Speed, dial type plain horizontal, table size 74½ in. by 16 in.
VAN NORMAN No. 36 (ram type, Universal Plain Table). Table 58 in. by 13 in.
PARKSON 1NA (Universal), table 46 in. by 10½ in.
CINCINNATI O8 Vertical.
HERBERT 28V Kneeless Vertical.

KEYSEATERS & KEYWAY MILLS
CARTER & WRIGHT No. 0.
CARTER & WRIGHT No. 2.
ASQUITH H.K.I.

GRINDING MACHINES
Surface
SNOW VB18, Vertical Spindle.
PRATT & WHITNEY 14 in., Vertical Spindle.
SNOW P24, Horizontal Spindle.

Cylindrical
LANDIS Type C, Universal, 10 in. by 24 in.

Internal
CHURCHILL No. 1 Cylinder Grinder.
CHURCHILL HBY.
CHURCHILL HCY.
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RADIAL DRILLS
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ASQUITH 3 ft. 6 in., LDR.
ASQUITH 3 ft. 9 in., PORTABLE.
ADCOCK & SHIPLEY, 28 in. PILLAR DRILL.

SLOTTERS
ORMEROD 8 in.
BUTLER 8 in.
BUTLER 12 in., with tilting body.
BUTLER 28 in.
BUTLER 28 in., with electric feed unit.
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★All machines fully motorised for 400/3/50 supply

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ALSO LATE TYPE PRODUCTION MILLERS, LATHES, GEAR MACHINES, CAPSTANS AND TURRET LATHES, ETC.

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SOAG MACHINE TOOLS LTD.,
JUXON STREET, LONDON, S.E.11
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G 229

SERVICE EDWARDS VALUE

ZEH & HAHNEMANN OPEN FRONTED UPRIGHT FRICTION SCREW PRESS. Pressure approx. 9 tons. Max. stroke 5½ in. Dia. of screw with 3 starts 1¾ in.
BROOKES OPEN ENDED UNDERCRANK GUILLOTINE. Motorised 415/3/50. Adjustable gauges. Capacity 49½ in. by 16 s.w.g. Gap depth 2 in. Weight about 10 cwts.
NEW MUIR & BENDER ALL-STEEL UNIVERSAL DOUBLE ENDED GEARED PUNCHING, SHEARING, SECTION CROPPING AND NOTCHING MACHINE, Model KBL 20. Motorised 400/3/50. Shear plate ¾ in. Crops rounds 2¼ in. Punches 1 in. by 1 in. Notches ⅝ in. Other sections in proportion.
NEW TRUMPF ELECTRIC THROATLESS SHEARING MACHINE, Model OMS 401/402. Motorised 400-440/3/50. Capacity 7 s.w.g. mild steel. Also suitable for polishing, grinding or wire brushing.
2 NEW ALL-STEEL PRESS BRAKES. Motorised 400/3/50. Capacity 8 ft. by ⅛ in. Stroke 3 in. Gap depth 18 in. With one set of 90 deg. vee-forming tools.
NEW SOENEN TYPE 1.5 GEARED OPEN FRONTED INCLINABLE PRESS. Motorised 400/3/50. Pressure 120 tons. Stroke adjustable from 1 in. to 9.27/32 in.

Photographs of the above are available.
MACHINE TOOLS, NEW AND USED, Of Every Description. Attractive Prices.

F. J. EDWARDS LTD.,
359-361, EUSTON ROAD, LONDON, N.W.1.
Telephone: EUSton 4681-3771.
And at
LANSDOWNE HOUSE, 41, WATER STREET, BIRMINGHAM, 3.
Telephone: Central 7606-7. G 552

SOAG

HIGH CLASS
VERTICAL BORERS
AVAILABLE FROM STOCK.

BULLARD 24 in. Spiral Drive, Motor drive. Turret head and side head, with square toolpost. Table dia. 24 in., max. swing 26 in., height admitted 20½ in.; 24 speeds 7.6-250 r.p.m.
BULLARD 36 in. Spiral Drive. Motor drive. Turret head and sidehead with square toolpost. Table dia. 34 in., max. swing 38 in., height admitted 24 in.; 12 table speeds 4.7-77 r.p.m.
RICHARDS 36 in. Double Column. Motor drive. Two swivel teolheads and pentagon, side toolholder, table dia. 34 in., max. swing 36 in., height admitted 30 in.; 12 speeds 1.88-45 r.p.m.
RICHARDS 36 in. Double Column. Motor drive. Two swivelling tool rams, left hand fitted for screwcutting, table dia. 34in., max. swing 36 in., height admitted 29 in.; 22 speeds 2.5-60 r.p.m.
GISHOLT 42in. Double Column. Motor drive. Two swivel tool heads, table dia. 40 in., max. swing 48 in., height admitted 33 in.; 12 speeds 2-60 r.p.m.
HARTMANN 43½ in. Single Column. Motor drive. Hexagonal turret head and sidehead with square toolpost. Table dia. 39½ in., max. swing 43½ in., height admitted 27½ in.; 16 speeds 3-52 r.p.m.
RICHARDS 48 in. Double Column. Motor drive. Two swivelling tool rams on cross rail, diameter of table 44 in., max. swing 48 in., height admitted 33 in.; 6 speeds 2.22-34.7 r.p.m.
ARMSTRONG CRAVEN 48in. Double Column type, two swivel tool rams, table dia. 50 in., max. swing 41 in., max. height under cross rail 38 in., 18 table speeds 2-45 r.p.m. Two available.
COLBURN 60 in. Double Column type. Two swivel tool rams, table dia. 60 in., max. swing 62 in., max. height, under cross rail 46 in.; 10 table speeds 2-37 r.p.m. Two available.
STIRK "HOLIMIL" 96 in. Double Column type, motor drive, two swivelling toolrams, table dia. 87 in., max. swing 96 in., max. height under cross rail 44 in.; 18 table speeds 0.6-31 r.p.m.

Full details of any of the above gladly sent on request to

SOAG MACHINE TOOLS LIMITED,
JUXON STREET, LONDON, S.E.11.
'Phone: RELiance 3373.
'Grams: Sotoolsag, London, S.E.11. G 230

FOR SALE.

OFFERED.

STEEL STORAGE BUILDINGS, HANGARS, GO-DOWNS, TROPICAL SHEDS, FACTORIES, ETC.—Write BELLMAN HANGARS, LTD., HOBART HOUSE, S.W.1. G 648

PROCTOR MECHANICAL STOKER—MISCELLANEOUS SPARE PARTS, completely new, for disposal.—Apply, J. MANDLEBERG & CO., LTD., ALBION WORKS, COBDEN STREET, SALFORD, 6, LANCS. (PENdleton 1441.) L 456

FOR SALE.

M.S. CHEQUER PLATES
(Unused Stock, Rusty).
¼ in. over chequer.
8 in. by 4 in., 6 in. by 3 in., 6 in. by 2.5 in.
100 Tons available.
Minimum 2-ton Lots.
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COMPANY MEETING.

THE HOFFMANN MANUFACTURING COMPANY

A SATISFACTORY RESULT

IMPROVED ORDER INTAKE MAINTAINED

MR. J. W. GARTON ON THE OUTLOOK

The annual general meeting of The Hoffmann Manufacturing Company, Ltd., was held on April 26 at the Connaught Rooms, Kingsway, London, W.C.2, MR. J. W. GARTON, J.P. (chairman and managing director), presiding.

The following is an extract from the statement by the chairman which had been circulated with the report and accounts for the year ended December 31, 1955 :

The profit of the Hoffmann Group for 1955 before taxation, but after all other charges, amounts to £1,079,802 and compares with £1,055,785 for the previous year. Income Tax and Profits Tax absorbs £543,114 in 1955 against £546,505 in 1954. The net profit of the Group for the year 1955 after taxation is, therefore, £536,688 and compares with £509,280 for 1954.

The marked improvement in the order intake, which I mentioned in my speech last year, continued throughout 1955 and together with the continuing drive to modernise plant and improve methods has produced this satisfying result.

APPROPRIATIONS

The question of the Ordinary Dividend has again been given very careful consideration by the Directors, and they recommend a Final Dividend of 5½d. per share (free of tax), which with the Interim Dividend of 1½d. per share (free of tax) will bring the cost of the distribution to £116,667 (free of tax) for 1955. The amount distributed for 1954 was £112,500 (free of tax). There is very little change on this account and you will recall that the Directors pointed out last year when the Capital was reorganised, that it was not their intention to recommend any increase in the amount to be distributed to the Ordinary Shareholders for 1955.

The Directors have again had pleasure in making grants: to the Group Benevolent Fund of £25,000 and the Fund for augmenting monthly staff and Directors' pensions of £10,000. These Funds, together with the original pension schemes, are a very great contribution to the welfare of all our employees.

The Fixed Assets Replacement Reserve of the Group has been increased by a transfer this year of £150,000 which brings the Reserve to the figure of £1,850,000. During 1955 the Group expended £340,000 on Capital Account and in addition there were capital commitments at the 31st December, 1955, of the Group amounting to £420,049. A transfer of £150,000 has been made to Group General Reserve, which now totals £250,000.

CAPITAL EXPENDITURE

For some years past I have referred to the Group Capital equipment programme, which included a Research and Development centre. This expenditure was partly re-equipment and also for buildings and machinery in order that we could meet the additional demands resulting from the expansion schemes of our customers. This capital equipment programme has been financed, and will continue to be, from the internal resources of the Group. The financial figures are given in the preceding paragraph.

BALANCE SHEET

The value of Stocks at the 31st December, 1955, has risen by approximately £62,000 after allowing for the increase in the Group Stock Reserve of £40,000, which the Directors consider to be prudent.

The liquid resources at the end of the year totalled £2,342,183 which compares with £2,319,575 at the 31st December, 1954.

Debtors have increased at the 31st December, 1955, by £129,090 and now total £1,188,125.

The excess of Current Assets over Current Liabilities now amounts to £3,103,150 compared with £2,994,032 last year.

SUBSIDIARY AND ASSOCIATED COMPANIES

Hoffmann Gloucester Limited continues to make a valuable contribution to the Group turnover and has had another successful year.

Hoffmann Tweedales Limited, in which Hoffmann Gloucester Limited has a 50 per cent. holding, had a better year in 1955, but towards the end of that year its manufacturing programme had to be substantially decreased due to reduced demand in the Textile Machinery trade. Whilst the position has slightly improved in recent months, the future is somewhat uncertain.

GENERAL

You will no doubt expect me to give you some idea of the future prospects of the Company and particularly as we are large suppliers to the motor and ancillary industries. At the present time we have a very good order book, but based on reports that have been received over the last few weeks, we expect that there will be some slowing down in demand. On the other hand, the labour situation was difficult last year and a considerable amount of overtime was worked which, after a period, results in wear and tear on both men and machines and a tendency to a fall in production. Although there are many difficulties in front of us at the present time, I have every confidence that your Company will secure a fair share of the bearing business of the country.

In conclusion, I extend on behalf of the Board sincere thanks to the Executives, Staff and Workpeople for their work during the past year.

The report and accounts were adopted and the dividend and bonus, as recommended, were approved.

L 502

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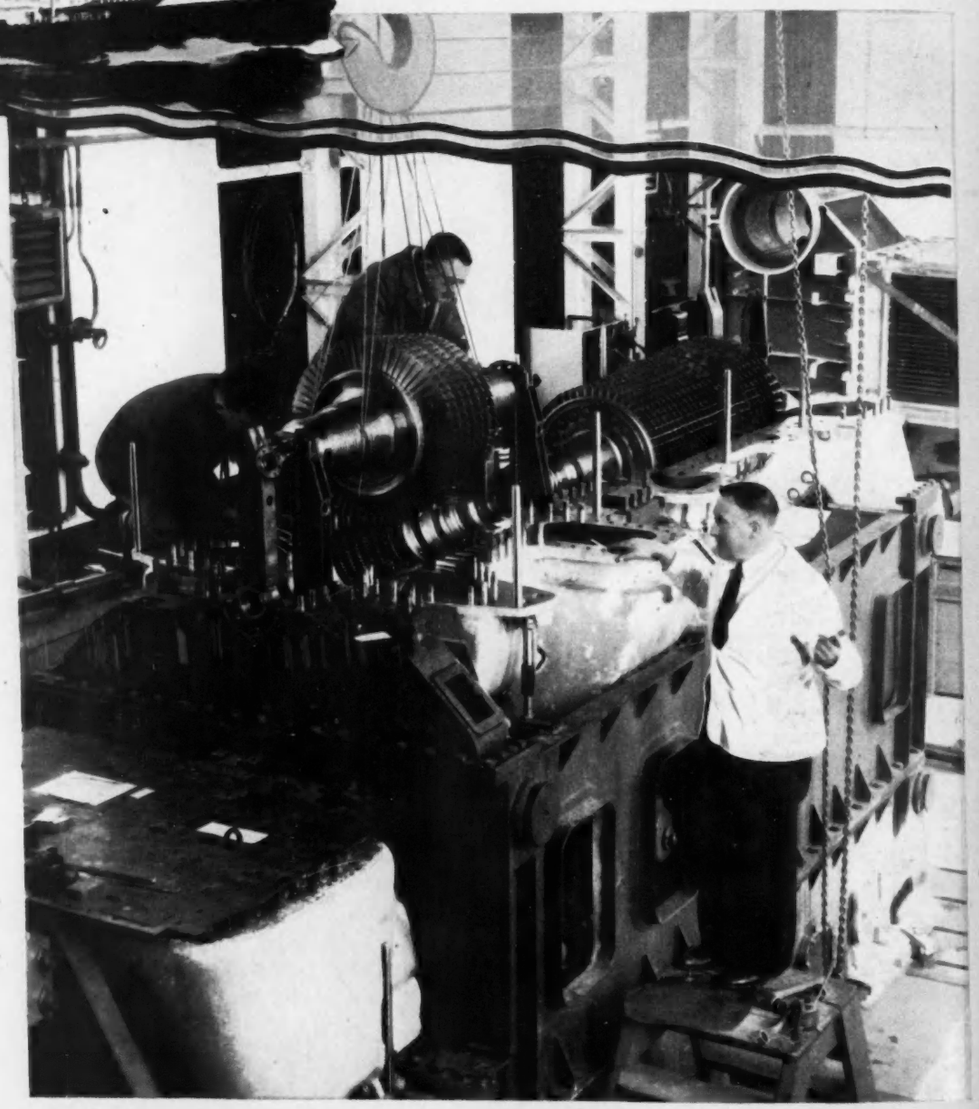

High-pressure turbine rotor and axial compressor rotor of BTH 1200-h.p. gas turbine installed in the Shell Tankers ship "Auris" of 12,000-tons dead weight.
This was the first ocean going ship to include a gas turbine in her main propulsion machinery.

Photograph by courtesy of:—
The British Thomson-Houston Co. Ltd.

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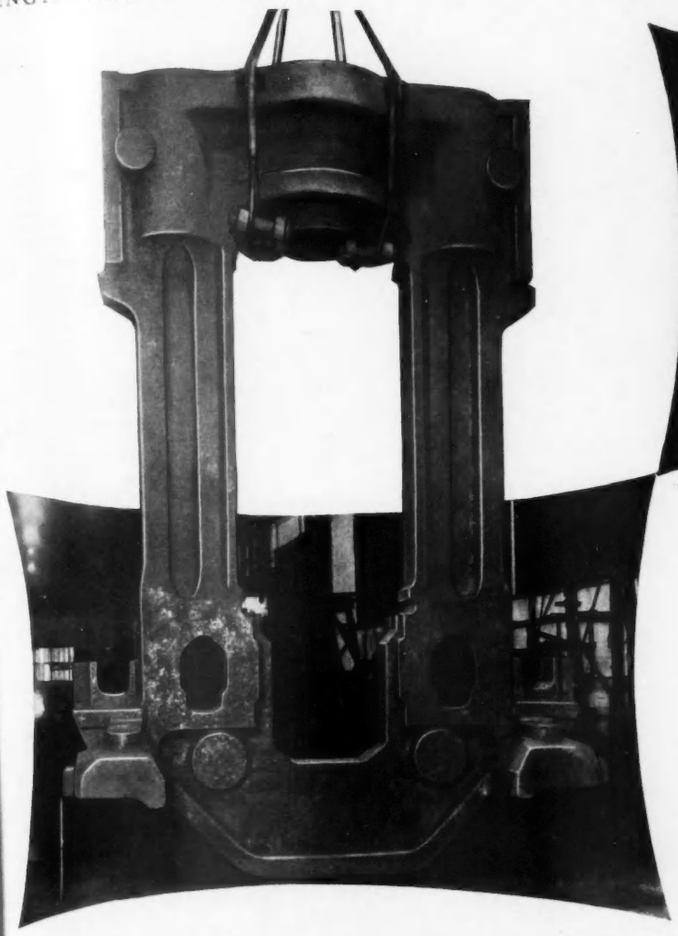

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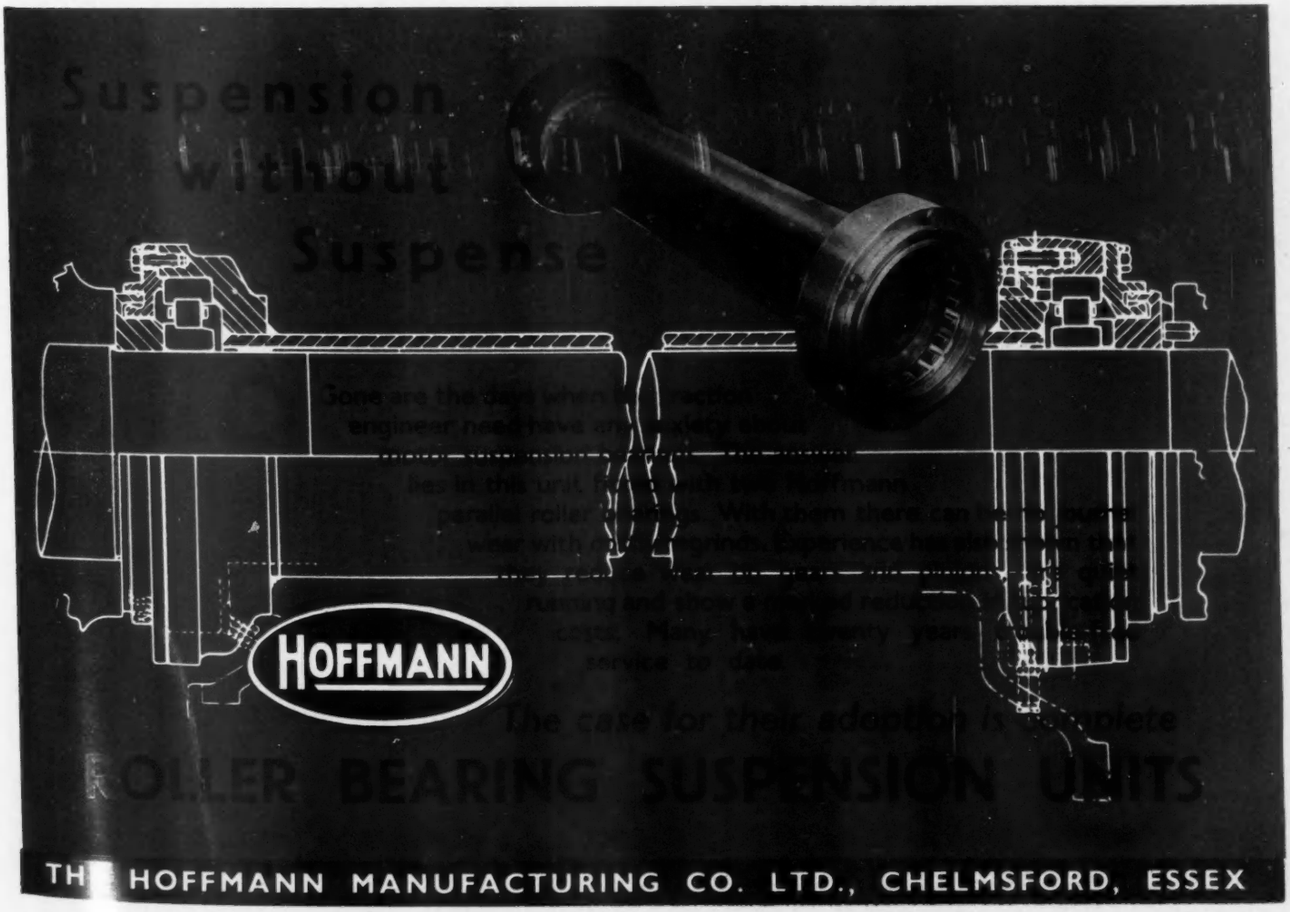

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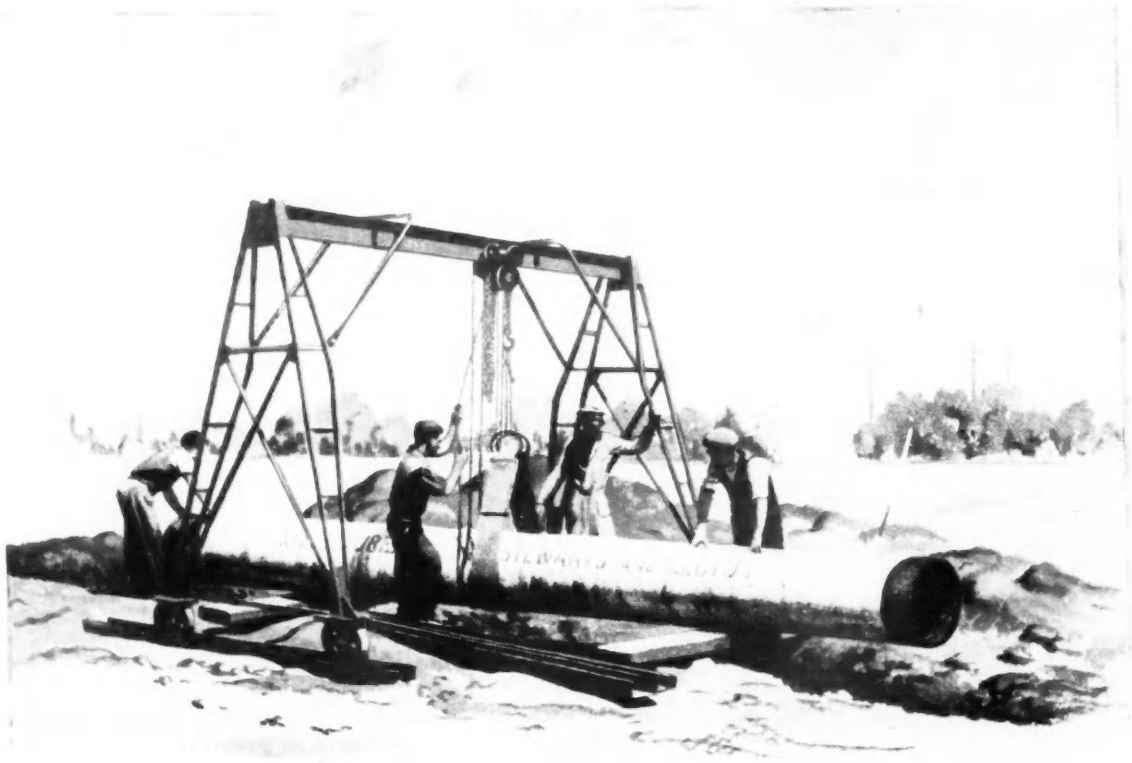

THE STEEL TUBE AGE

Part of a 24-inch S & L steel water main, about 22 miles long, being laid by the West Hampshire Water Company from their works on the River Avon at Christchurch, to provide the water supply to the Esso Refinery at Fawley, Southampton.

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